THE ESSENTIALS OF MODERN SURGERY

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PREFACE TO THE FOURTH EDITION

TWELVE years have passed since the first appearance of this book at a time when England lay under the threat of war which was soon to become reality In spite of the uncertain times it has met with so kindly a reception that a fourth edition is now called for All of us who have taken part are indeed grateful for the loyal support we have been given

Once again we have striven to bring every section up to date We are fortunate in securing the co-operation of Mr Holmes Sellors who has taken over the late Tudor Edwards chapter on Chest Surgery While holding closely to the original set up of the chapter Mr Sellors has given a clear presentation of the present position of this branch of surgery and has added a section of those diseases of the heart and great vessels amenable to surgical treatment We are confident that our readers will agree that he has maintained the high standard set by his predecessor

Another member of our original team has passed on and we miss sadly Lionel Colledge not only for his own work but for his constant encouragement and help Mr J F Simpson has taken over his chapters He has had time to revise thoroughly only the section on the Ear and to bring the other sections up to date Before another edition is needed he will have completely overhauled the whole subject of Oto-Pharyngo-Laryngology

The new antibiotics have been described the surgical reticuloses have been set out at greater length a brief review of the surgery of the adrenal gland has been added a number of illustrations have been deleted and others more instructive have taken their place In spite of these changes this edition has not increased in size

Again we thank our many friends who continue to take so lively an interest in this book chief among them being Professor W D Newcomb to whom we never go in vain for help and advice Mrs Handfield-Jones has again shared the work of re-arrangement proof reading and indexing and to

her we render our grateful thanks. Mr Macmillan and Mr Parker of E & S Livingstone have given us never failing help and have met our wishes with ready co-operation and courtesy and to them both we offer our most sincere appreciation

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THE DISEASES OF THE BRAIN AND ITS COVERINGS
DISEASES OF THE SCALP AND SKULL

CONTENTS

THE
ESSENTIALS OF MODERN SURGERY

CHAPTER I

INFLAMMATION AND REPAIR

INFLAMMATION is the active reaction of a living tissue to injury irritation or invasion, providing its structure and vitality are not immediately destroyed It embraces a series of changes designed to limit and eliminate the attacking agent remove all dead tissues and finally to restore the area as nearly as possible to normal Repair therefore is an integral part of the inflammatory process

The causes of Inflammation may be classified as (1) bacterial (2) traumatic, *e.g* wounds blows and crushes (3) thermal *e.g* burns and frost bite (4) electrical, *e.g.*, all forms of electrical current X rays radium and ultra violet light (5) chemical, *e.g* irritant liquids and gases and (6) neoplastic

The body s response varies with the potency and virulence of the pathological stimulus but in general it may be said that the more intense the irritant the more rapidly and actively do the tissues react and the result is described as *Acute Inflammation* Less noxious stimuli applied more gradually produce a slower response which is known as *Chronic Inflammation* In spite of the widely divergent features presented for example by acute staphylococcal osteomyelitis and chronic tuberculous osteitis both share in reality the same fundamental pathological processes though in different proportions These processes and the changes they produce must now be considered in detail

THE INFLAMMATORY REACTION

Vascular Changes.—These may be studied in the thin web of a frog s foot observed under the microscope after application of an *irritant* At first there is a generalised dilatation of arterioles capillaries and venules and the stream within them flows more rapidly This is the stage of *active hyperæmia* when capillaries not ordinarily in use are taken into service and pulsation is often to be seen in them Within two hours the circulation becomes slower (*retardation*), the vessels being still widely dilated. Finally *stagnation* or stasis occurs and this may or may not end in thrombosis At this time it will be

ed that the white corpuscles are drifting out of the central axial rent and collecting in the peripheral stream in close contact with the pillary walls This *margination of the leucocytes* leads to their dherence to the vessel wall and soon a most striking phenomenon can be observed Polymorphonuclear leucocytes begin to pass through the vessel walls by a process called *diapedesis* which is seen chiefly in capillaries Large numbers of these white cells collect in the peri vascular tissues in which they exhibit amoeboid movement This migration of leucocytes is followed by that of red cells to a degree which varies greatly in different types of infection being most marked in certain very severe examples

These vascular changes are brought about by the action of certain H substances (Krogh and Lewis) of which histamine is the best known and which are set free when tissues are damaged These substances also exert a chemotactic effect upon leucocytes thereby encouraging diapedesis

The Inflammatory Exudate.—It will be realised that changes in the walls of small vessels which allow solid corpuscles to pass, must in evitably permit the fluid constituents of the blood to filter through This *increased permeability* affects the lymphatics as well as the blood vessels it leads to an outpouring of fluid and accounts for that swelling of the tissues which is so characteristic of all inflamed areas. This exudate varies in composition according to the nature and severity of the stimulus In slight injury it is thin of low specific gravity and low protein content being rapidly removed by the lymphatics when the injury is severe the exudate closely resembles blood plasma an contains a marked proportion of fibrinogen, which is converted int fine fibrils of fibrin by the action of thrombokinase liberated from th damaged tissue cells The exudate is also rich in the normal antibodie of the blood such as agglutinins precipitins and bacteriolysins

Abscess Formation.—An acute abscess is frequently the result o invasion by *Staphylococcus aureus* whose presence in the tissue rapidly calls forth the defence mechanism described above Cells i the immediate vicinity of the cocci are killed and a small nidus o bacteria and dead cells is formed Soon this is surrounded by a zon of fibrin containing polymorphs and the fluid exudate rich in antibodie The nearest leucocytes gain contact with the cocci and engulf them i their protoplasm a process known as *phagocytosis* In a mild infectio such as a blind boil the digested bacteria are removed and the sign of inflammation slowly disappear

Usually however the defence fails to achieve so rapid and complet a victory Polymorphs of the advance guard are themselves destroyed the cocci continue to multiply and the central area of dead cells i thereby increased in size being added to by death of tissue cells cause by the toxins of the invading bacteria The leucocytic barrier is no reinforced more polymorphs go into action and eventually the infectio is controlled and walled in. Progressive liquefaction of the necrot debris is brought about chiefly by digestive enzymes set free b disintegrating leucocytes and to a lesser extent by a specific facto secreted by staphylococci which digests protein. The resulting liqui

is called *pus* whilst the lining of the cavity is k
membrane

Untreated an abscess may continue to spread u
mucous lining of a cavity or tube gives way and the pu
after which the abscess cavity heals The object of su
cases is to provide an outlet for the pus as soon as possible

End Results of Inflammation.—I Resolution is the restorat
the affected part to its normal condition it can occur only when
attack is weak and the patient s resistance high In it the stages o
inflammation are simply *reversed* Slowly the blood stream quickens
white cells cease to adhere to the vessel walls the fluid exudate is
absorbed by the lymphatics and the cells either return to the blood
vessels or disintegrate and are absorbed Finally vasodilatation
passes off the vessels regain their tone and all signs of inflammation
disappear

II Abscess Formation which is described above

III Ulceration in which the changes are similar to those in an
abscess except that they occur upon a surface

IV Necrosis and Gangrene —When an extensive area of tissue
is devitalised by severe injury or virulent infection it dies and remains
as an inert mass An inflammatory reaction occurs at the junction of
living and dead tissues and the latter are separated from the former
When the dead area is small it is extruded as a *slough* but if a large
area of a functioning unit of the body dies we speak of *necrosis* of bone
and *gangrene* of soft parts

V Repair is an integral part of an inflammatory process It is
not necessarily the same in every pathological condition for example
the edges of an incised wound may be either accurately drawn together
by sutures, insecurely united by blood clot or widely separated and
further they may be sterile or infected Again a considerable mass of
tissue may have died and a gaping cavity remain Although the
processes of healing may vary in such widely *different* conditions
nevertheless the fundamental pathological principles are essentially
the same

HEALING AND REPAIR

The foregoing description has dealt chiefly with those reactions of
the circulatory system which are designed to surround and control the
invader but we have not yet discussed the mechanism by which the
body repairs the damage

Tissue Changes.—*If an inflamed area is examined* microscopically
its surface will be *seen to* consist of cellular debris organisms and
polymorphs Immediately around is the zone of dilated vessels and
exuded *fluid* which is separating and bathing the cells of the part
In this œdematous area a great number of *large mononuclear cells*
(histiocytes) can be observed exhibiting amœboid movement and active
phagocytosis. Their origin remains a subject for debate and *although*
in the early stages of inflammation they all *appear alike* it *is probable*
hat they arise from diverse sources and eventually have different

tions to fulfil. Suffice it to say here that they are derived either from the large lymphocytes of the blood, wandering cells from tissue spaces fixed connective tissue cells of the part or the reserves in the reticulo-endothelial system Whatever their origin their primary function is phagocytic and within forty-eight hours they will contain polymorphs in varying stages of disintegration, red blood cells and organisms For this reason Metchnikoff named them macrophages in contradistinction to polymorphs the microphages

As the acute phase of the inflammation subsides other cells make their appearance chief amongst them being *small lymphocytes* Others are intermediate in size between them and their larger brothers the large mononuclears, namely *plasma cells* These are oval in shape and have an eccentric nucleus, in which the chromatin is arranged in nodules around the periphery—the cart-wheel effect Those two cells are associated more commonly with the chronic forms of inflammation, so that under such conditions we speak of a small round celled reaction." Eosinophil and basophil leucocytes may also be seen but they usually denote certain specific types of infection.

We shall frequently speak of *giant cells* in connection with foreign bodies, chronic inflammation such as tuberculosis and syphilis and certain new growths A giant cell is formed by fusion of a number of cells of similar type *e.g* large mononuclear endothelioid or tumour cells They are therefore characteristically multinucleated and the arrangement of their nuclei in each disease is a matter of some slight significance

Granulation Tissue.—As the phase of active phagocytosis begins to die down, the large mononuclears continue to divide but now show signs of differentiation. In their early stages they are embryonic in character but their offspring start to reproduce cells of a more mature type Some of these become oval their nuclei assume a spindle shape and long protoplasmic processes are developed. These latter form an interlacing trellis work with those of neighbouring cells and as they grow older adult fibrous tissue cells or collagen fibres are laid down around them These are *fibroblasts* beginning to lay the foundation of all healing processes viz *fibrosis*

While these embryonic cells are preparing to form adult fibrous tissue endothelial cells are growing out from dilated capillaries and forming strands of cells advancing towards the healing surface At first they appear as parallel uncanalised columns but soon a lumen develops blood corpuscles enter and a new capillary is formed These unite with their neighbours with the result that a series of vascular arcades is formed with their convexity towards the healing surface As this formation of *granulation tissue* (*i.e* capillary arcades plus fibroblastic support) continues, the arcades increase in depth and number until finally the gap is bridged and the healing surfaces are united Meanwhile in the deeper *i.e* older layers deposition of collagen fibre increases the capillary network is reduced to a small number of better developed vessels and eventually firm fibrous tissue alone remains to mark the place where the body had triumphed over the invading forces Such an area of fibrous tissue is called a *scar*

Variation in the Healing Process.—I HEALING BY FIRST INTENTION — In a clean incised wound as in a surgical operation very few cells are destroyed and infection is absent Its edges are accurately apposed by sutures the cleft being sealed by a fibrinous exudate The typical stages of inflammation are so slight as to escape notice polymorphs digest the fibrin and a thin zone of granulation tissue paves the way to the formation of fibrous tissue

II ORGANISATION OF BLOOD CLOT —Less perfectly apposed wounds and small cavities will contain a varying amount of blood clot Here again no organisms are present and no pus produced Clot takes the place of necrotic debris described above fibroblasts and polymorphs digest the fibrin large mononuclears follow to remove all disintegrated matter and the whole is replaced by granulation tissue Finally the area is permeated by fibrous tissue and healing is complete This process is known as organisation of a hæmatoma and is one of great importance in pathology

III HEALING AFTER SUPPURATION —The healing of an abscess has been described in detail

IV HEALING BENEATH A SCAB —Ulceration or suppuration upon a surface differs from the general picture only in one respect The granulation tissue forms a raw exposed area which demands protection. This is afforded by coagulation of the exudate which forms a thick secure shield beneath which the tender healing tissues can work without interruption This scab is shed when delicate surface epithelium has grown in and covered the granulating area

V HEALING OF AN ULCER.—In some cases a scab does not form a raw area remains exposed and pus is discharged freely Epithelium grows in from the edges and under favourable conditions eventually covers in the whole area Frequently however the formation of granulation tissue is too exuberant and needs controlling by surface applications of silver nitrate There is a limit to the size of a raw area which can be epithelialised in this manner In such cases healing is brought about by skin grafting

TYPES OF INFLAMMATION

Various types of inflammation are described according to the degree of severity and the site of attack The primary division of inflammation is into acute and chronic In acute inflammation the changes described above take place rapidly and in maximal degree in response to a sudden noxious irritant Chronic inflammation may arise as a later stage of the acute or *de novo* in response to a less noxious stimulus applied over a longer period Both acute and chronic types have their own particular histological response—polymorphonuclear in acute and lymphocytic in chronic

A *catarrhal* inflammation is one affecting mucous membranes and is essentially mild in degree It is characterised by an outpouring of mucus from the affected cells. Of such a type is the well named streaming cold

If the process should increase in intensity cellular destruction takes place and pus is formed

the virulence of the attack is excessive cellular death may occur and *gangrenous* inflammation results

Should inflammation occur in a serous cavity *e.g* pleura or peri toneum the milder stages are called *serous* inflammation an outpouring of intracavital serum being the typical feature This in later or more severe cases tends to clot and the term *fibrinous* is applied.

In some very acute inflammations the cellular destruction is so marked as to cause actual bleeding into the tissues concerned—*hæmorrhagic* inflammations Such a very acute process occurring in a mucous surface tends to produce the so-called false-membrane (*e.g* of diphtheria) from a mass of necrotic cells on the surface welded together by fibrin, thus the terms *membranous croupous* or *plastic* inflammation

In discussing inflammation in any particular organ the description *interstitial* or *parenchymatous* is used according to whether the supportin or essential cellular tissue of that organ is chiefly involved.

ACUTE INFLAMMATION

CLINICAL PICTURE

Local Condition.—Since Celsus about A.D 50 described the four cardinal signs of inflammation as calor rubor tumor and dolor (heat redness swelling and pain) only one other has been added, namely loss of function

Heat is due to hyperæmia The increased temperature can be appreciated by the hand and measured by a surface thermometer

Redness is also due to hyperæmia In the earliest stages of in flammation the colour is bright red, fading and returning with equal rapidity on pressure During the stage of retardation the colour is more dusky sometimes even bluish and pressure evokes a slower response. Later still when stasis has occurred the purple colour is more obvious and does not fade on pressure Further the dissolution of red blood corpuscles frees hæmoglobin, which adds to the colour and indeed may lead to a lasting browny red discoloration.

Swelling is due partly to vascular congestion and partly to the exudate Its extent varies considerably according to the tissue affected In lax distensible structures such as eyelid dorsum of the hand and scrotum it is very marked in bone it is absent

Pain is the result of pressure of the exudate upon sensory nerve endings It is therefore due to raised tension a cause of pain we shall meet with in many surgical diseases If the affected structures are rigid and inelastic tension rises rapidly and steeply and pain is severe where the swelling is great pain is likely to be slight Any factor which increases this tension will aggravate the pain for example by allowing an infected hand to hang down. The pain of acute inflammation is described as throbbing since the vasodilatation allows pulsation in the smaller vessels and each beat raises the tension and so increases the pain.

Pain is not always limited to the inflamed area but may be referred by a sensory nerve either to its peripheral distribution or by its central connections

Tenderness is a special type of pain produced by pressure and is one of the most important clinical signs in the diagnosis of acute inflammation

Loss of Function is often due to a reflex immobility of muscles designed to prevent pain but mechanical reasons such as swelling of a joint may account for it Another important factor is the local toxic damage to the cells of the part caused by the invading organisms

Constitutional Involvement.—Inflammation always causes some degree of general constitutional response This is due to the absorption of toxins from the site of local reaction into the blood stream In non bacterial cases this response is slight and transient in bacterial cases it is always more pronounced though varying considerably in intensity In very virulent inflammations the toxæmia may be sufficiently potent to cause death

This general reaction is described clinically as the febrile state Fever or pyrexia implies a raised body temperature This is accompanied by an increased pulse rate and very often respiration is also more rapid. The pulse is more full and bounding than in the normal person Headaches are frequent and a general feeling of malaise makes the patient restless and irritable

Anorexia (distaste for food) is usually present and thirst is excessive The skin is hot and dry the face flushed The mouth is dry and the tongue covered by a white fur In the more prolonged acute fevers the gums and lips become coated with masses of dried mucus called *sordes* This frequently leads to the breath being very foul Constipation is the rule and the motions when passed are very offensive The urine is scanty and highly coloured with a high specific gravity and contains excessive quantities of uric acid urates and quite commonly a trace of albumen.

In the later stages of acute fever the toxæmia leads to emaciation anæmia (the complexion now becoming pasty and sallow) and general muscular weakness and exhaustion Vomiting may be a marked feature In the most acute cases semi-consciousness passes into true delirium collapse occurs and the patient dies

Fever may be continuous at a certain level it may fluctuate but never return to normal (remittent) or occur at definite periodic intervals (intermittent) Some particular diseases have characteristically a sudden excessive pyrexial response the temperature returning either to normal or to lower levels just as rapidly as it rose originally Such an exacerbation accompanied by a shivering attack is termed a *rigor*

The heat regulating mechanism of children is far from stable and high temperatures in young patients have not the same significance as in later life unless continued over a considerable period of time Fever is the outward clinical manifestation of the body s general response to noxious attack (usually bacterial) and hence again provided it falls within a reasonable time a high temperature is indicative of a good resistance When suppuration is present a small amount of pus if

under tension will produce a very marked febrile reaction quite out of proportion to the local condition.

TREATMENT

In order to avoid unnecessary repetition we shall describe general principles rather than details of treatment, which latter will be dealt with in relation to different infections and regions of the body No reference will be made here to the treatment of open wounds which follows in Chap VII

Local Treatment.—(a) PREVENTION —Many causes of inflammation are avoidable but this covers so vast a field of preventive medicine that its range can only be indicated here In industry prevention of injury and prophylaxis of infection are of immense importance as is also that of endemic and epidemic infective diseases.

(b) REMOVAL OF THE CAUSE.—This is a relatively simple matter when the cause is evident *e.g* a foreign body a buried suture or ligature a carious tooth etc More active measures may be needed, such as excision of an infected focus (an acutely inflamed appendix) of a sinus or fistulous track or curettage of unhealthy tissue

(c) GIVE REST TO THE INFLAMED PART —The lesson taught by Hilton in Rest and Pain so long forgotten, has again become the guiding principle of treatment Wherever possible complete immobilisation should be assured by plaster of Paris bandages firm fixation in splints bandaging, etc The function of inflamed internal organs glands gastro-intestinal tract etc., must also be reduced to a minimum Enforced rest can easily be overdone and the resumption of activity is to be encouraged as soon as the acute stage of inflammation has definitely subsided otherwise loss of function may lead to prolonged incapacity

(d) RELIEVE TENSION —Tension is due to hyperæmia and accumulation of inflammatory exudate If under pressure the fluid causes great pain and it is then a source of danger since it may embarrass the circulation and lead to an increased area of necrosis It is relieved by several means.

1 *Elevation of a limb* assists the venous and lymphatic drainage and diminishes pain. Its importance is not sufficiently realised The limb should be supported in a special bed rest fitted with an adjustment to vary the angle of elevation Different types are needed for the upper and lower limbs

2. *Surgical Measures* —(a) Incision and drainage of an abscess should be provided as soon as its presence is diagnosed (b) multiple small incisions are useful in certain types of inflammation *e.g* cellulitis, in which tension is high, but little actual pus has collected (c) local relief may be obtained by the use of leeches and by scarification followed by dry and wet cupping (methods now obsolete in this country but worthy of a limited return to favour)

3 *Surface Applications* —(a) Heat either moist or dry is valuable in reducing tension and relieving pain Its many methods of application are described in Chap XII (b) cold in the form of ice bags

evaporating lotions and a flow of cold water is of limited use but care must be exercised in its employment for it may do more harm than good by depressing the local circulation

(e) INCREASE THE BLOOD SUPPLY.—This is done by inducing hyperæmia which is brought about in two ways *Active hyperæmia* encourages an increase in arterial flow by producing vasodilatation by various forms of radio therapy such as radiant heat infra red rays and short wave diathermy *Passive hyperæmia* is venous in type and is best obtained by the use of the pneumatic limb compressor of a sphygmomanometer by which the venous and lymph flow can be impeded without any restraint upon the arterial supply Bier's or Klapp's suction glasses of varying sizes are used to produce local hyperæmia (Fig 1)



FIG. 1

A Bier's cupping glass with rubber suction bulb. (*Allen & Hanburys.*)

(f) PREVENT MIXED INFECTIONS gaining access to an open wound (see p 120)

General Treatment.—(a) REST *in bed is essential in* all but the most trivial inflammation Neglect of this principle accounts for a vast loss of man hours work in every class of the community Refusal to give up work may be admirable in theory but is uneconomic in practice

(b) DILUTION AND ELIMINATION OF TOXINS.—The organs of excretion must be assisted to get rid of circulating toxins as rapidly as possible A daily action of the bowel is essential but too active purging should be avoided Kidney action is increased both by the quantity of fluid introduced into the body and by the use of diuretic drugs Elimination by the skin is aided by heat and diaphoretics

(c) PRESERVATION OF THE WATER BALANCE.—In many inflammatory diseases there is a great loss of fluid by profuse discharges and it is remarkable how rapidly signs of dehydration appear This loss must be made good and in addition to plentiful drinks saline should be given rectally subcutaneously and intravenously These methods of infusion and transfusion and their indications are described in Chap VIII

(d) DIET *should be reduced to its most nutritious as well as easily* assimilable form *e.g* milk meat-juices and extracts chicken and calf's foot jelly etc

(e) RELIEF OF PAIN.—Severe and prolonged pain is most debilitating and wears down the patient's powers of resistance Its relief is obtained partly by local measures and partly by analgesics or hypnotics (*aspirin, bromides* nembutal morphia etc) With this is associated the control of sleeplessness a matter of the greatest importance

(f) SUPPORT THE HEART.—In certain conditions and in strong healthy patients the blood pressure may be sufficiently high to demand relief this may be done either by drugs or by a carefully controlled venesection. Stimulants will be called for if strength is failing brandy strychnine and *digitalis* being the most valuable A moderate degree of rise in temperature is a favourable sign of the body's efficient resistance and only hyperpyrexia (105 F and over) needs treatment Tepid sponging of the whole body or even ice packs may be

required while aspirin phenacetin and quinine will temporarily lower the temperature

(*g*) SPECIFIC REMEDIES —These include antisera the sulphonamide group of drugs and penicillin (Chap XI) together with streptomycin and aureomycin

(*h*) RESTORATION OF FUNCTION —Treatment does not cease with the control and resolution of the inflammation, but suitable methods must be applied to restore the affected area to full use and power (Chap XII)

CHRONIC INFLAMMATION

The pathological processes underlying all inflammations are essentially the same but in chronic inflammation some changes are more and others less prominent than in the acute condition. There is a wide range of virulence and there are therefore many intermediate stages between the extremes of acute and chronic reactions. In chronic inflammation the stage of active hyperæmia is slight but prolonged diapedesis is on a small scale while the fluid exudate contains little protein and fibrin. The greatest difference concerns the tissue response and the cells with which the area is infiltrated, chronic inflammation being characterised by a small round-celled " reaction These cells are probably lymphocytes and occur in large numbers while others are derived from the endothelium of blood vessels lymph vessels and spaces Plasma cells are commonly seen and eosinophils are present in certain diseases The end results vary considerably according to the nature of the inflammation and the part of the body affected Tuberculosis and syphilis have their own individual reactions but in general it may be said that in most instances chronic inflammation ends in the formation of fibrous tissue

Clinical Picture.—A mild degree of pyrexia often noticeable only at certain times of the day (especially evening) is the usual feature but an increase in temperature is frequently absent Patients are steadily absorbing small doses of toxins and this leads to a state of chronic poisoning of the whole system known as *toxæmia* The patient becomes pale has no appetite and loses weight rapidly and if relief is not forthcoming literally seems to fade away

Local signs are different to those of acute lesions. Heat and redness are absent but swelling may be marked. Pain is less acute and is not throbbing in character while tenderness is correspondingly diminished Loss of function is often a prominent feature as for example in a tuberculous joint

One complication of prolonged inflammation especially if associated with long-continued suppuration is *amyloid disease* This change affects chiefly the smaller vessels of the kidney spleen, liver and small intestine in which it leads to extensive pathological degenerations and eventually the death of the patient Reference should be made to text books of Pathology and Medicine for a full picture of the pathological changes and the clinical picture

Treatment.—LOCAL (*a*) *Remove the Cause*, if possible Such poison factories as the teeth tonsils gall bladder and appendix can be removed

antra and chronic abscesses can be drained and foreign bodies or diseased particles of bone extracted

(b) *Rest the Affected Part*—Whether its function be mechanical or physiological continued activity will often cause prolongation of a chronic inflammatory process The part concerned must be temporarily given a rest from its normal function to allow its cells to concentrate on the process of repair This applies equally to part of a limb or to an organ But in that the process is a protracted one common sense and judgment must be used in preventing disuse atrophy At a certain stage of proceedings there is no doubt that reasonable and controlled activity will assist recuperation

(c) *Physical Methods*—In long-standing inflammation heat is of considerable value and is usually employed as dry heat (hot air or radiant heat baths) or can be engendered by massage Pressure also finds a greater field of usefulness in chronic than in acute inflammation and the same applies to passive hyperæmia One line of therapy peculiar to chronic inflammation is the use of counter irritants although this again is essentially a means of producing localised hyperæmia (active) The substances in commonest use are tincture of iodine mustard plasters, cantharides (Spanish fly) and Ung Hydrarg Co (" Scott s dressing ") The cautery—actual or diathermy—can also be employed in this connection

GENERAL.—This may be further subdivided into non-specific and specific. *Non specific* general treatment follows the same lines as enunciated for acute inflammation above As chronic inflammation will usually automatically imply a prolonged absorption of small doses of toxin into the general blood stream the stimulation of the various excretory functions forms a very important part of treatment

Specific Treatment involves the use of sera and drugs proved to be of therapeutic value in the particular disease concerned

SCARS

A scar is a mass of devascularised fibrous tissue which in a superficial wound is covered by a single layer of epithelium. This epithelium has no papillæ no hair follicles no sebaceous glands no lymphatics and usually no nerves

A superficial scar involving skin only may become almost completely obliterated. Scars involving deeper tissues and internal organs never disappear In their early stages before all the capillary loops have been squeezed out of existence by fibrosis they may be obviously red in comparison to surrounding tissue but when fully established they are dead white and have a glazed appearance

Various pathological conditions can occur in scars

1 **Weak Scars** usually occur in places subjected to considerable mechanical strain *e.g* the neck amputation stumps distended abdomen etc Very often there is an added element of mild sepsis and this may lead to actual *ulceration* of the scar Chronic irritation of the cicatrix as for instance in the continued rubbing of an artificial limb is again an important factor in the weakening of scars

Such scars are typically stretched out and broadened thin and easily irritated. Treatment is symptomatic consisting in local support and protection local stimulating applications or in the absence of actual infection, excision and resection to obtain healing by first intention

2 **Contracted Scars.**—Excessive contraction of scars is not un common and may occur equally well in superficial structures and in deeper tissues A new scar contracts to about two-thirds of its original length In the skin over-contraction is particularly prevalent after extensive burns (Fig 2) and is most marked even sometimes producing severe deformity if occurring on the face neck or flexures

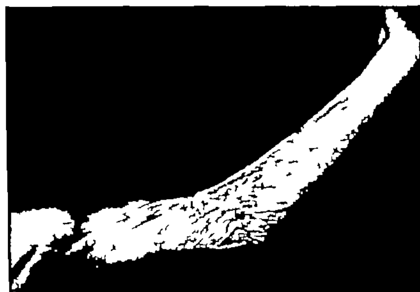


FIG. 2

Severe scarring of the region of the elbow following a burn showing limitation of full extension as a result.

of the limbs Excessive fibrosis in deeper structures may lead to muscular contractures as in torticollis (*q v*) or to partial obliteration of some part of the intestinal canal or urinary ducts *e.g* urethral stricture (*q v*)

Treatment of the cutaneous type of excessive contracture consists in either gradual stretching division or excision It should be remembered that important structures are liable to become attached to the under surface of such scars and due care is required either in stretching or cutting them Any bare area caused by division or excision is treated by suitable skin grafts (*q v*)

3 **Adherent Scars,** one form of which is the *Depressed Scar* occur when two or more tissue planes one of which at least is mobile are bound together by fibrosis Such scars occur either superficially (skin adherent to tibia) in muscular planes (quadriceps adherent to femur) or in the viscera (post-operative adhesion of intestine to

peritoneum) Depressed scars are usually the result of healing in an old-standing sinus

Adherent scars may lead to considerable deformity in the limbs they may be responsible for false ankylosis of a joint and are usually painful Treatment consists in gradual stretching by massage and movements or by operative freeing of adhesions

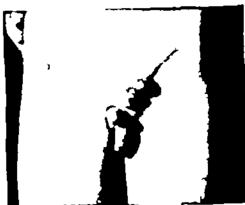


Fig. 3

An extensive keloid forming in the scar of an operation for left inguinal hernia.

4 **Painful Scars.**—These are due to involvement of a nerve trunk in the contracting fibrous tissue of the scar This leads to persistent and severe pains which may be felt not only at the site of pressure but radiating to the distribution of the nerve concerned. It is typically encountered in the severed nerve trunks of an amputation scar where the terminal neuroma becomes involved in the fibrosis Injection of alcohol locally may serve to paralyse the nerve but if this is not practicable it must either be freed by operation from the scar tissue or excised.

5 **Pigmented Scars.**—These are usually due to extraneous particles introduced at the time of injury e.g gunpowder and coal dust But the scar of a healed chronic ulcer is often browny red in colour from staining with hæmatoidin. Syphilitic scars are dead white in colour Tattooing is deliberate pigmentation. Apart from æsthetic reasons treatment is not required On the face and hands such scars may demand excision.

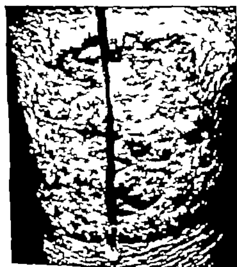


Fig 4

Marjolin's ulcer A squamous-celled carcinoma which has arisen on an old chronic varicose ulcer

6 **Hypertrophied Scars.**—A true hyperplasia of scar tissue in its early stages is common, particularly in the presence of mild infection. A more serious condition is known as *Keloid* (Fig 3) when the scar becomes raised above the surface sends extensions into neighbouring tissues especially via stitch holes and is dusky red in colour This change is liable to occur in any situation where incisions cannot be placed exactly in the lines of skin tension thus it is a likely sequela to block dissection of the neck which entails an incision along the sternomastoid muscle

The most widely accepted theory of etiology is that it is a condition of fibromatosis in the walls of the occluded capillaries in the original scar tissue A keloid is often intensely itchy and always disfiguring Treatment is most disappointing Excision with resuture nearly always leads to recurrence but skin grafting the excised area may avoid this Both X-rays and radium have in isolated cases produced cures A certain proportion disappear spontaneously In plastic surgery especially in situations which require a perfect scar it has become the custom to give a short course of X ray exposures with the object of preventing the formation of keloid scars

7 **Neoplastic Scars.**—Malignant changes are rare scars particularly affected being those subjected to chronic irritation, such as X ray burns. The growth is a true carcinoma very slow-growing and not painful until it spreads to normal tissue Ulceration is common, the condition then being known as *Marjolin s* disease (Fig 4) Treatment consists in early and wide excision followed by skin grafting

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CHAPTER II

INFECTION AND IMMUNITY

INFECTION

INFECTION implies the penetration of living bacteria into the tissues of the human body This invasion may occur either through a break often microscopical in the continuity of the body s surface whether it be of skin or mucous membrane or by direct inoculation into the deeper tissues as happens in the case of bites from animals and insects or of wounds by sharp foreign bodies Surface infection takes place not only by contact of bacteria with the skin but also by inhaling them into the respiratory tract or ingesting them with food or fluids into the alimentary canal Moreover it is known that bacteria can enter the body through an intact skin or mucous membrane

Bacteria are low forms of plant life They are unicellular and multiply by fission (schizomycetes) contain no chlorophyll and require for their existence moisture a suitable temperature certain salts combined nitrogen and in some cases oxygen To avoid the ill-effects of lack of moisture many of them are capable of forming spores which can resist high degrees of desiccation over long periods The optimum temperature for most bacteria is somewhere in the neighbourhood of body temperature Their nitrogen supply is derived either from living tissues direct (*parasites*) or from dead organic material (*saprophytes*) Both types are found in human pathology and under certain conditions one can be transformed into the other *facultative parasites* Those bacteria that require oxygen are known as *aerobic* those that do not *anaerobic* Again some transmutation of forms is possible thus the existence of *facultative aerobes* The morphology and characteristics of the many and varied forms of micro-organisms is dealt with to some extent in a later chapter but for a full description textbooks of bacteriology should be consulted

The Distribution of bacteria is widespread They exist in large numbers in the air especially that of cities in water and soil The bacterial content of air varies with many factors around the mountain summits and above mid-ocean it is negligible in enclosed spaces devoid of air currents particles of dust and bacteria sink to the ground and the air previously heavy laden becomes almost sterile Many natural water supplies teem with dangerous organisms so that domestic water has to be purified before delivery The soil especially in heavily manured areas contains at least two organisms very lethal to human beings namely those of tetanus and gas gangrene Human skin mouth

intestinal tract external ear anterior nares, vulva and anterior urethra are all heavily contaminated, but very few of these bacteria are capable of producing disease whilst others require specially favourable conditions in which to do so

Pathogenicity and Virulence.—Bacteria which can produce disease are defined as *pathogenic* and only a small number of this vast family of organisms can be classed as such. Furthermore not only must bacteria be pathogenic to man, they must also obtain access to tissues in which they can thrive and produce their noxious results. For example if tetanus bacilli are swallowed no harm will ensue but if they are placed in a cut in the skin a typical lesion develops conversely little ill-effects follow if cholera bacilli are introduced beneath the skin whereas their presence in the intestine has grievous effects

The severity of an illness depends upon the strength of the attacking organism and the defensive powers of the body Individual bacteria *e.g* streptococci may produce a mild local lesion or endanger the patient's life This variability is referred to as the *virulence* of organisms and we speak of them as of high or low virulence Moreover some bacteria normally non pathogenic are capable of becoming highly so if their environment is suddenly and profoundly altered Conditions lowering the general health and powers of resistance of an individual such as previous illness exhaustion exposure starvation poor hygienic surroundings hæmorrhage or concomitant infection all adversely affect the body's response

Under certain conditions bacteria may be shut off in a part of the body still alive but temporarily inactive In due time they will die out but occasionally they survive and a return to favourable conditions permits a recrudescence of their activity This is known as a *latent infection*

Certain infections are disseminated by people known as *carriers* who although harbouring pathogenic organisms are not affected by them owing either to an acquired immunity from a previous attack (*e.g* typhoid) or to natural powers of resistance (*e.g* diphtheria)

Products of Bacterial Activity—These are many and varied including gases, pigments enzymes alcohol, acids and alkalis Their importance is bacteriological rather than surgical in that they are used chiefly in the typing of various strains of bacteria Some organisms produce a proteolytic enzyme (*leucocidin*) which digests leucocytes whilst others destroy red blood cells (*hæmolysins*) and set free their hæmoglobin and reference will continually be made to the gravity of hæmolytic streptococcal invasions But the most important chemical result of all bacterial metabolism is the production of toxins

Toxins are non-crystalline non-dialysable substances which have never been isolated in pure form. They are always associated with proteins and proteoses and are probably adsorbed upon the surface of protein particles Every toxin is specific which is to say it produces one disease and that one only They are divided into two groups

1 EXOTOXINS are secreted by bacteria both in the body and in culture media from which they can be separated by filtration Their introduction into the body produces the clinical picture of the disease

The best examples of exotoxins are those of *C. diphtheriæ*, *Cl. tetani* and *Cl. botulinum* but an increasing number of bacteria are coming to be recognised as exotoxin producers. They are extremely potent and their minimum lethal dose is far smaller than that of an alkaloid poison but unlike the latter they do not act immediately after injection but only after a certain latent period. Finally one of their most important properties is that of stimulating the body to produce an antitoxin a substance capable of neutralising their poisonous effects. Just as its parent toxin is specific so antitoxin will counteract only its own disease. Certain animal venoms and vegetable poisons have the same property of developing an antivenom.

2 ENDOTOXINS are more intimately associated with the bacterial body and little or no diffusible toxin is found in culture media. Our knowledge of endotoxins is scanty.

The Infective Reaction.—The sequence of events in infection now becomes apparent. At the site of bacterial invasion a primary focus develops and gives rise to a typical inflammatory reaction spread to the regional lymph glands follows and if the defence mechanism breaks down bacteria enter the blood stream and infection is disseminated all over the body. Spread to remote parts occurs in another way for example the exotoxins of tetanus spread along peripheral nerves to reach the central nervous system while others circulating in the blood stream produce their effects at a distance for example peripheral nerve palsies in diphtheria. Bacteria are rarely found in the blood in any numbers or for any length of time although mild bacteræmia is probably more common than is usually thought. Their presence together with their toxins in the blood stream may constitute a very dangerous condition known as **septicæmia** (p. 28). Should bacteria or minute particles of infected cellular debris lodge in a radicle of the peripheral circulation a local inflammatory lesion will result—a condition named **pyæmia** (p. 30).

IMMUNITY

We have seen that our whole environment is laden with potentially pathogenic organisms and yet a relatively small proportion of the population succumb to diseases produced by bacteria. Obviously there must exist a lack of susceptibility to or protection against these ubiquitous micro-organisms and their toxic products. This is called *immunity* which may be either natural or acquired.

Natural Immunity is a part of our innate inheritance enabling us to repel bacterial invasion. It varies not only with the species concerned but also with the individual and to a certain extent with the tissue attacked. Thus certain diseases are peculiar to man such as gonorrhœa syphilis scarlet fever and typhoid which are unknown among the lower animals. Similarly a certain number of individuals will escape infection in a severe epidemic (*e.g.* of scarlet fever in a school) although constantly exposed to infection. In addition to certain inherited powers of resistance there are other factors which influence an individual's susceptibility.

Certain conditions are said to predispose to infection such as cold wet and exhaustion either separately or even more effectively when combined Age is an important factor either extreme particularly infancy being less able to ward off infection Starvation insanitary conditions, lack of sunlight play their part Severe hæmorrhage certain chronic poisons and long-standing debilitating diseases all tend to a lowering of resistance to infection.

Locally certain tissues seem ill able to defend themselves for example fat but this is probably a question of a poor blood supply Injury to a part depresses its vitality and favours infection whilst the presence of foreign bodies such as metal fragments, pieces of dead bone and surgical ligature materials render tissues more liable to attack Again powerful antiseptic chemicals when applied to open wounds may do more harm than good by destroying living tissue cells

Acquired Immunity is of an entirely different type and is of two distinct varieties active and passive

ACTIVE IMMUNITY develops as the result of a series of vital processes within the patient's tissues whereby certain specific substances are formed and retained in the blood stream These are referred to as *antibodies* which are able to neutralise or destroy the toxin which has produced them so that a patient cannot contract that particular disease Active immunity can be acquired in two ways either naturally or by artificial means The victim of scarlet fever typhoid smallpox and many other less serious infectious fevers rarely suffers from a second attack During his illness and subsequent convalescence he has built up a supply of antibodies and these afford almost complete protection in the future

The artificial production of active immunity is based upon the observation that repeated sub-clinical attacks of infection will result in an immunity similar to that conferred by an active attack There are several methods available (*a*) the inoculation of attenuated strains of live bacteria *e.g* vaccination against smallpox (*b*) the injection of prophylactic vaccines such as Wright's against typhoid and para typhoid—the well known T.A.B vaccine Haffkine's against plague and others (*c*) the injection of poisonous toxins as in the production of therapeutic antisera in horses and (*d*) the use of specially prepared toxins called toxoids such as toxin-antitoxin mixtures formol toxoid or alum precipitated toxoid which achieve their end without giving severe toxic reactions

Such acquired immunity takes a little time to develop usually about a week, but it persists for a long time varying with the disease for example in diphtheria it is permanent with T.A.B vaccine it lasts for about two years in cholera about a year while in some diseases it lasts but a few weeks

PASSIVE IMMUNITY is a temporary protection conferred upon man or animals by introducing into the circulation a supply of antibodies manufactured by a process of active immunisation in a horse or by a human patient while convalescent from disease The familiar anti tetanic anti-diphtheritic and anti-gas gangrene sera are examples of the former while antisera for measles whooping-cough and scarlet

fever illustrate the latter Their effect is immediate but transient in duration

Mechanism of Immunity—We refer to antibodies but we are ignorant of many of the processes concerned in their production Certain types of antibodies are described —

1 Antitoxins, whose action is essentially a neutralising one

2 Lysins which break up not only bacteria but cells of the body e.g red blood cells

3 Agglutinins, which cause bacteria to clump thereby reducing their potency and exposing them to a more intensive attack

4 Precipitins with a similar action

Clinical Applications.—A DIAGNOSTIC —The complement fixation tests for syphilis (Wassermann reaction) gonorrhoea and other diseases are based upon antibody reactions The agglutination properties of the enteric group of organisms is made use of as a test (Widal) while the intradermal injection of vaccine or toxin has given us tests for scarlet fever (Dick) diphtheria (Schick) for tubercle (Mantoux) and many others

B THERAPEUTIC —Antitoxic sera are used in the treatment of diphtheria tetanus scarlet fever bacillary dysentery and snake bites Anti bacterial sera are used to combat pneumococci meningococci and anthrax bacilli

A vaccine is made by suspending living organisms in saline estimating their number per cubic centimetre and diluting to a convenient dosage The bacteria are then killed either by heat formalin or other antiseptic Prophylactic vaccines are of the very greatest importance in producing immunity but their value as therapeutic agents in the presence of active disease is almost negligible

ANAPHYLAXIS

This curious phenomenon is closely related to although superficially so completely at variance with immunity and was discovered accidentally by Richet during researches into certain toxic substances If a solution containing a foreign protein for example horse-serum is injected into an animal a change occurs whereby the subject is rendered highly sensitive to any further injection of this particular protein Should a second dose be given fourteen or more days later the animal rapidly becomes gravely ill and may die Several factors influence both the occurrence of anaphylactic shock and its severity The second or activating dose need be quite small but the larger it is the more severe will the symptoms be The route by which it is administered is important ingestion by mouth is harmless subcutaneous injection gives a moderate reaction intravenously its effects are very severe and the intrathecal method gives the gravest results of all The time interval between the two injections is important just as immunity takes some days to develop so does the anaphylactic state indeed they go hand in hand The hypersensitivity persists for many months and slowly disappears as do the antibodies of an immune serum Finally

the nature of the protein does not matter egg albumen vegetable proteins grass pollens etc all produce the result The reaction, however is specific Anaphylaxis therefore is a condition of hyper sensitivity produced either naturally or by the injection of a foreign protein.

ANAPHYLAXIS IN MAN

In human pathology this rarely occurs except in association with the use of antitoxic sera either in prophylaxis or treatment and many of the reported cases are concerned with tetanus. If a patient receives an injection of antitetanic serum some months after a previous dose violent symptoms and even death may follow Acute anaphylactic shock is characterised by mental distress dyspnœa cyanosis and collapse in man death is fortunately a rare event It can readily be appreciated how immensely important the subject is in time of war and how essential it is that every injection should be entered upon a patient s case paper There is one type of individual subject to ana phylaxis without a previous injection viz. the person who is sensitive to horse-protein and suffers from so-called horse-asthma

Desensitisation.—At any time but especially in war the indications for an injection of an antitoxin in a patient known to be or suspected of being sensitive may override all other considerations In such cases the patient is first tested by giving 0 1 c c of serum intradermally and if no erythema or urticaria develops within forty minutes the intra venous injection can be given. If a reaction occurs, the patient must be desensitised and two methods are available

1 Non urgent Cases —A dose of 0 025 c c of serum diluted in saline is given subcutaneously and then is doubled every half hour When 1 c c has been reached 0 1 c c of serum diluted with saline is given intravenously and again this is doubled every half hour until 25 c c of serum has been given a tedious but safe method

2 Urgent Cases *e.g* tetanus.—5 c c of serum are diluted with 50 c c of saline and intravenous injections of this mixture are given as follows —first 1 c c followed four minutes later by 3 c c then three minutes later by 10 c c two minutes later by 25 c c after which the full dose of undiluted serum may be given. All injections must be given slowly and stopped immediately any untoward symptoms occur

Serum Sickness.—An anaphylactoid phenomenon follows in a considerable number of non-sensitised people upon a single injection of antitoxic serum. Although not dangerous this serum sickness may be exceedingly alarming to the patient After about one week to ten days itching and urticaria of the skin suddenly appear and in more severe cases the urticaria may assume the giant form and there may be swellings of internal mucous membranes with dyspnœa hæmorrhages, pain and effusion into joints etc

Allergy—Some individuals have a natural susceptibility to certain proteins or they may suddenly acquire it The most familiar examples are foodstuffs oysters, crabs and lobsters, certain fruits such as straw berries and certain vegetable proteins amongst which the grass pollens,

which produce asthma are prominent Allergy i more related to medicine but in different section of thi book referen e will be made to this condition

Treatment of Anaphylactic States.—Severe cases are treated by intramuscular injection of to 8 minim of a 1 1000 solution of adrenalin Atropin $\frac{1}{10}$ gr subcutaneou ly and solutions of calcium chloride intravenously are also used

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Hilton's method This consists of a simple skin incision through which is thrust into the abscess cavity a pair of sinus forceps or closed artery forceps On opening the blades a sufficient aperture can be made to evacuate the pus and insert a drainage tube

Should the infecting organism be sensitive to penicillin an entirely different method may be tried and in some cases may give excellent results and avoid an incision. The overlying skin is sterilised and a medium-sized exploring needle is made to enter the abscess All the pus is removed by aspiration and a small quantity of penicillin solution (4 to 6 c c) injected This is repeated every twenty four hours during which injections of penicillin intramuscularly are being given in the usual way (see Chap XI)

The remaining essential in the treatment of an abscess is rest and this should be obtained by bandaging splints etc The general treatment of inflammation (p 9) applies in all details to that of abscess

CHRONIC ABSCESS

A chronic abscess is most commonly due to tuberculous infection (cold abscess) and is considered in a later section (p 41) A certain number are the result of pyogenic organisms in which case these have been either of low virulence in the first place or left behind after the treatment either natural or surgical, of a pre-existing acute abscess. This is commonly the case in bone infections Pathologically there is the formation of pus with the minimum of inflammation clinically fluctuation and perhaps slight pain, without the signs of inflammation

In a chronic pyogenic abscess it is unusual to find any but a very few attenuated atypical organisms either in the pus or in the walls of the cavity In contradistinction to this the wall of a tuberculous abscess cavity is the most usual site in which to discover the offending organism The treatment of the specific type is considered later (Chap XLVIII) A chronic pyogenic abscess requires incision, removal of slough and granulation tissue and drainage just as does the acute variety

SINUS AND FISTULA

Many non-specific chronic abscesses are however clinical entities owing to their persistent connection with a surface either the skin or some internal cavity Such connections which are really tubular ulcers are either blind at one end or complete via the abscess cavity from one surface to another The former is termed a **sinus**, the latter a **fistula**. Such tracks are lined with granulation tissue and later even with actual epithelium and surrounded by a zone of fibrosis. The persistent non-closure of a sinus or fistula may be due to many causes amongst which may be mentioned (1) inadequate preliminary drainage of an abscess (Fig 5) (2) foreign bodies infected cellular debris especially bone fragments or catgut ligatures at the bottom of the track, (3) continual secondary infection from neighbouring structures as is the case with rectal and urinary fistulæ (4) want of sufficient rest to the part (5) epithelialisation of the track and

exces ive fibrosis around it (6) specific infection especially by tuberclo or syphilis (7) the development of a neopla m at the affected site (8) general constitutional causes and union between an internal mucous membrane and the skin

The treatment of a sinus or fi tula varies according to its position ıt in general it may be said that where possible e g with a foreign dy the cause should be dealt with and a residual chronic abscess equately and efficiently drained The track itself may be raped and cauteri ed or eferably excised com ete the resultant wound ıng allowed to granu te up from the bottom ther with or without ght gauze packing adiant heat and infra d light greatly as i t is process As much st as pos ible mu t e secured and general eatment instituted



Fig 5

A chronic sinus injected with lipiodol to show its extent.

In cases in which such ng-continued suppura ion persists certain eneral changes take place n the patient due to he constant absorption f small doses of toxins nto the blood stream The so-called hectic ever" is the outward and visible sign of this chronic toxæmia The patient has a constant ise of temperature in the evenings and at this time feels well As the temperature falls towards morning often to below normal sweating is profuse and exhaustion is felt Gradually anæmia and wasting become evident and the condition if untreated may lead to a fatal issue

It is in such patients that **amyloid disease** occurs Its appearance is an indication for radical treatment as soon as possible If the suppurating focus is in a limb amputation may be the only means of saving life and elsewhere as radical an excision as possible should be performed

BOILS (FURUNCLES) AND CARBUNCLES —A boil is an acute abscess originating in the infection of a hair follicle or submucous gland usually by the staphylococcus. A carbuncle is a more diffuse infection of the subcutaneous tissues leading to the formation of a series of inter communicating abscesses

Both these conditions are considered in detail in Chap XIII

ULCERATION NECROSIS AND GANGRENE (INFECTIVE) —These conditions in their many and varied manifestations show a wide range of naked-eye appearances and clinical features. Nevertheless they all afford examples of the basic pathological principles underlying all inflammatory processes. In some these may be acute in type while in others more chronic forms are seen A full description of each will be given in the different sections of Chap IX

DIFFUSE INFECTION

CELLULITIS

This is a spreading inflammation of the subcutaneous or loose fascial connective tissue due usually to infection from the streptococcus pyogenes It is particularly prone to occur in lax tissues *e.g* scalp orbit pelvis scrotum and neck and is really an expression of the breakdown of natural defensive barriers due to either excessive virulence of the attacking organism or a lowered general resistance on the part of the patient The infection is usually derived from some wound which although more commonly deep and poorly drained, may in some cases be microscopical Sometimes infection may be carried by the blood and lymph streams from a distant focus

Clinical Picture—There is often an incubation period of two to three days after which the onset is heralded by a rigor and general malaise with headache

Fever is marked, the temperature rising to about 103 to 104 F and fluctuating slightly at that level. Rigors may be repeated, anorexia is complete the tongue dirty and furred, bowels constipated and urine scanty and high-coloured. Vomiting is often a feature in children. Delirium and sleeplessness occur in most cases

Locally the infective focus may at first show only mild signs of inflammation, but extending from it there develops a rapidly spreading diffuse area of brawny infiltration. If superficial this is often slightly raised, red, intensely tender and covered by shiny skin. The pain is at first aching in character but may later become throbbing The edges of the inflamed area are indefinite and fade off into surrounding normal tissue Slowly the brawny area will soften until it feels boggy to the touch and if untreated the overlying skin will develop vesicles which discharge a thin, often sanious sero-pus Below the skin necrosis sloughing and gangrene may take place over a very considerable area The lymphatic glands draining the affected tissues are enlarged and tender

Treatment.—Careful attention to wounds will prevent many cases of cellulitis In the early stages complete rest to the affected part where possible is the first essential and this should be combined with some means of increasing the local blood supply Antiphlogistine poultices or radiant heat baths will promote active hyperæmia Bier's method of producing passive hyperæmia can also be used for periods of ten to twenty minutes two or three times a day Spread of the inflamma-

tion or any tendency to soften call for more active intervention and multiple incisions should be made through the skin into the subcutaneous tissue but stopping at the deep fascia level For obvious reasons these incisions are made parallel to the main structures (nerves vessels and tendons) of the limb the wounds being lightly packed with sterile gauze Warm baths in which the whole limb can be immersed give much relief

General treatment consists in the administration of sulphadiazine and penicillin and in providing a plentiful nourishing diet and ample fluid keeping the bowels freely open and giving such drugs as may be required to ensure relief of pain and adequate sleep Alcohol (brandy) undoubtedly does good in these cases A blood transfusion may on occasions be a life-saving measure

SPECIAL VARIETIES OF CELLULITIS

A **Scalp** —This usually results from a puncture wound piercing the occipito-frontalis aponeurosis where the loose areolar tissue at this level allows of easy diffusion In bad cases the whole scalp is lifted and floats on a bed of pus Subsequent infection of cranial bones meninges and brain may occur The less common variety is a subcutaneous cellulitis In neither case does sloughing of the skin occur owing to the good blood supply of the scalp Local treatment is by multiple incisions in line with the main vessels

B **Orbit.**—This follows either penetrating wounds or spread of infection from within the skull The eyeballs become protruded the eyelids œdematous and vision is markedly affected, often permanently Necrosis of the bony walls of the orbit damage to the optic nerve the ocular muscles and the eyeball and cavernous sinus thrombosis are all more than likely sequelæ Treatment consists in adequate exposure and drainage of all orbital wounds combined with chemotherapy

C **Neck.**—This is caused by some focus of infection in the mouth or throat and starting as it does in deep lymphatic glands usually is at first confined beneath the deep cervical fascia The brawny painful swelling is very characteristic (a well known form being that in the submental region *Ludwig's angina*) and it may be some days before softening occurs and pus tracks to the surface (p 367) In the meantime extensive spread in the neck and to the mediastinum may have occurred and pressure on important vessels and nerves and venous thrombosis have produced serious symptoms The greatest danger is œdema of the glottis with its concomitant acute dyspnœa which may demand a tracheotomy Again incisions into the deep cervical fascia to relieve tension even before suppuration is evident are the correct treatment The constitutional reactions which in this type are most severe will need adequate chemotherapeutic and symptomatic treatment

D **Scrotum.**—This results in most cases from extravasation of urine after rupture of the urethra The process is very acute sloughing of the skin extends over a considerable area and the general reaction is severe

E **Pelvis.**—Pelvic cellulitis is due either to wounds which penetrate to the loose areolar tissue of this region and are imperfectly drained or to infection which spreads either directly or indirectly from the various pelvic organs Being a deep-seated inflammation local signs are at first absent but the constitutional reaction is marked. In due course a tender mass will be felt per rectum or per vaginam and ultimately pus may track to the surface (either above Poupart's ligament or into the perineum) or burst into one of the internal organs or peritoneum Secondary venous thrombosis with subsequent pyæmia is by no means uncommon Adequate drainage once suppuration has occurred is the essential treatment

GENERALISED INFECTION

SEPTICÆMIA

SEPTICÆMIA is the condition which results when the circulation becomes flooded with bacteria due either to the failure of local natural defensive reactions at site the of infection or to delayed or inadequate treatment Once in the blood stream the organisms proliferate therein and, in a true case of septicæmia can always be found in blood cultures A minor degree of this state of affairs in which organisms are present but do not multiply in the blood is known as bacteræmia and is rather the expression of an overflow from the local focus of infection than a true blood infection. Clinically the two conditions may often be indistinguishable

Streptococci especially the hæmolytic types are by far the commonest cause though staphylococci may also be found as well as many of the so-called specific organisms such as *Pneumococcus B coli B pyocyaneus Gonococcus B welchii B pestis B anthracis* etc.

The actual site of infection may be very obvious as in the case of gangrene of part of a limb or a large area of cellulitis but may on the other hand quite frequently be almost indistinguishable It is well known that seemingly harmless small wounds scratches or pricks may give rise to a fatal septicæmia. The wounds from post mortem examinations and septic operations are notable examples

Clinically septicæmia is usually initiated by a severe rigor which is seldom repeated. The temperature except in the worst cases when it is subnormal rises to a considerable height (104 to 105 F) and remains about this level The pulse is fast and weak and the heart becomes dilated hæmic murmurs often being present The skin is dry and hot and may show multiple petechial patches (from hæmolysis) or even an erythematous desquamating rash. The tongue is parched and furred Thirst is insatiable but the appetite disappears. Diarrhœa is more common than constipation, the stools often being streaked with blood and mucus The urine also contains blood and albumen and is scanty and highly coloured Leucocytosis is well marked, except in the worst cases Restlessness and sleeplessness soon pass into active delirium and, unless treatment is successful, coma will ensue and death occur in less than a week.

Post mortem changes are quite distinct Rigor mortis is late and slight but decomposition and post mortem lividity rapid and marked. The blood is very dark and coagulates slowly Serous cavities contain

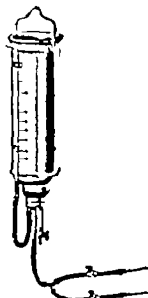


Fig. 6

Apparatus suitable for either subcutaneous or intravenous saline infusions; for the latter only one needle would be required.

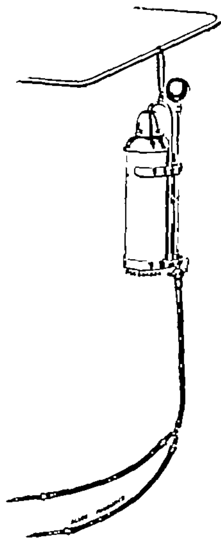


Fig 7

A modified thermos flask adapted for use with subcutaneous, intravenous and rectal saline infusions. For rectal use a soft rectal catheter would be substituted for the needles.

small quantities of blood-stained fluid and subendothelial petechial hæmorrhages of the pleura peritoneum pericardium and lining of major vessels are very typical The spleen is enlarged soft and friable and like the liver and kidneys shows definite cloudy swelling The lungs are congested and œdematous

Treatment.—The local focus should be either excised or thoroughly cleaned and adequately drained Amputation may be indicated

Rest in bed is of course essential and ample fresh air a good nourishing diet stimulants (especially alcohol) and soporifics must be provided To ensure an adequate intake of fluids it should be a routine to give 7 to 8 pints of 10 per cent glucose saline daily either by the intravenous (continuous drip method) or rectal routes (Figs 6 and 7) Penicillin is a specific remedy for many cases of septicæmia as the majority of responsible organisms are susceptible to the drug In

a moderate degree of pyrexia due to sepsis in the wound, but towards the end it may rise to phenomenal heights (110° or 112° F) There will be excessive sweating and a scanty urine loaded with albumen The mind remains distressingly clear throughout

The differential diagnosis includes strychnine poisoning hydrophobia, tetany meningitis, hæmorrhage into the cerebral ventricles catalepsy and hysteria

TREATMENT

A Prophylactic.—In war every wounded person, and in peace every patient with a wound in any way likely to be contaminated with tetanus must be given a prophylactic dose of antitetanic serum (A.T.S) 3000 units being administered immediately the dose and time of administration being entered upon the case sheet Tetanus toxoid is also being used with satisfactory results

B Therapeutic treatment has four objects (1) to neutralise toxin (2) to prevent its further absorption (3) to limit spasms and (4) to maintain the patient s strength. These are attained by the following procedures

1 The use of antitetanic serum at the earliest possible moment after diagnosis is imperative The route by which it is administered has been a matter of controversy in the past but to-day it is generally agreed that the intravenous method is superior to all others. It is accepted that intrathecal injection is no more efficacious and it has the disadvantage of producing in many patients a considerable degree of shock further it requires a general anæsthetic to control the spasms which make insertion of the needle impossible Local intramuscular injection is of little value

The technique is as follows an initial dose of 100 000 units A.T.S. is given intravenously it should be warmed and run in slowly Twelve hours later 50 000 units are given, after which 25 000 units are injected every twenty four hours for four days (see also p 20) Although *Cl tetani* is sensitive to penicillin in test culture results of clinical use have not been convincing

2 Treatment of the wound provides a problem requiring a nice judgment. Unnecessary interference and rough handling may liberate an additional amount of toxin, so that more harm than good results. Treatment will depend upon the extent site and number of wounds, whether one or all are infected with tetanus and whether thorough excision is possible Extensive lacerated wounds of the extremities with compound fracture may demand amputation as the surest way of saving life whilst others may be ideal for excision In any event operation should be delayed for three hours after the first dose of antitoxin the wound is then explored all dead and devitalised tissue removed together with every particle of foreign bodies and every recess laid open. It is then treated with a powerful oxidising dressing, of which zinc peroxide is the most efficient A cream is made of 40 per cent free oxygen powder (supplied by Laporte & Co., of Luton ...) and this is gently syringed into every part of the

remainder of which is loosely packed with gauze impregnated with the cream

3 All possible stimuli likely to excite spasm should be avoided and for this reason a perfectly quiet darkened room with careful and silent nursing and the minimum of interference is essential. Cole has shown that avertin given per rectum in doses of ... per kilogram of body weight controls spasm better than anything ... Other drugs used are nembutal chloral and paraldehyde

During the past five years curare has been used in surgical anaesthesia to produce profound muscular relaxation ... also been used in the treatment of tetanus to overcome the ... lar spasms by paralysing motor nerve end plates Curare is ... istered in normal saline intravenously either by continuous drip ... repeated injections The drug is fairly quickly metabolised ... dose of ... to 30 mg per hour will be found safe In ... nce is ... yet available to permit of a true assessment of ... n this disease

4 As much nourishment as possible should be g... rule only fluids are acceptable and trismus may make it ... give ... in any other way than rectally If feasible a Ryle ... uld be passed through the nose into the stomach and left ... r regular feeding

Attention must be paid to the bladder as retention ... in a number of patients

GAS GANGRENE

Gas gangrene results from a group of organisms and not from any single bacterium as does tetanus They fall into two classes those that ferment sugars and others that break down proteins All belong to the type—**Clostridia.**

The sugar-splitting group (saccharolytic) include *Cl welchii Cl septique* (vibrion septique of the French) and *Cl oedematiens* while the proteolytic representative is *Cl sporogenes*

Clostridium welchii is the most important and is here described as typical of the saccharolytic group It is a large gram positive bacillus, short stumpy and square ended is non motile and produces spores only under special conditions It ferments all hexoses and starch and in so doing develops large quantities of gas A milk medium shows a characteristic change—the so-called stormy clot It produces a powerful soluble toxin which has a specific effect upon cardiac muscle and against which an antitoxin can be prepared

Cl sporogens has no great pathogenicity but is usually associated with *Cl welchii* whose action it accelerates and accentuates to a marked degree It is a gram positive bacillus and is actively motile It splits sugar to a slight degree but decomposes meat with the production of a foul smelling gas.

All these organisms are anaerobic and the wounds which favour their development are similar to those in tetanus Essentially gas gangrene is a disease of muscle other tissues such as subcutaneous

fat and fascia may be affected— gas gangrene cellulitis, but only in muscle does this infection assume its formidable character In volved muscles change their colour becoming a dull brick red (Fig 8) and lose their contractility Their fibres and bundles are separated from their sheaths being surrounded by a clear space full of gas In this way infection spreads rapidly up a muscle which is killed partly by the bacterial toxins and partly by deprivation of its blood supply from gaseous distension of its sheath In such a dead muscle bacilli multiply in large numbers the vessels are thrombosed and the whole area is converted into a dead mass exhibiting gas crepitation The discharge is not purulent but sanious containing many bacteria and few leucocytes and emits so pungent and characteristic an odour that the diagnosis can be made upon that sign alone



Fig. 8

Gas gangrene

A, normal muscle; B, "red death"—note the cavitation by bubbles of gas; C "black death." (*Surgery of Modern Warfare.*)

Gas gangrene varies somewhat in its manifestations The foregoing description is typical of most infections in which there is a reasonable expectation that energetic treatment will save the patient's life and possibly his limb also Less commonly in very severe injuries especially when the main vessels of a limb are damaged massive gas gangrene of the whole limb supervenes and the outlook is hopeless In such cases a gas septicæmia is likely to usher in a fatal ending and at post mortem bubbles of gas will be found in almost every organ notably the spleen and liver

Types of Wound.—We have shown that wounds prone to gas gangrene are similar to those in tetanus viz. lacerated wounds with much ti ue damage and punctures with little or no drainage The close association of gas gangrene infection with devascularisation of limb or part should be borne in mind It has been our experience peace time that another injury liable to this infection is one in hich an exten ive flap of skin has been widely raised from the

underlying deep fascia with extensive soiling but without much muscle damage In war military casualties present a high incidence of gas gangrene and during the bombing of Britain we found a high pro portion of bomb wounds containing *Cl welchii* In many of these cases contamination had been by the dust and powder of house debris and not street refuse

There is yet another type of gas infection which may be termed "autogenous gas gangrene Wounds of the buttock and perineum in which gross or unsuspected damage to the rectum is a complication sometimes develop an acute infection from organisms normally present in the fæces. Similarly in rare cases fæcal soiling of the abdominal parietes during operations for intestinal obstruction may have the same unhappy effect

CLINICAL PICTURE

The incubation period varies between twenty four hours and a few days but is usually short During the first few hours the wound appears to be progressing normally and the patient is recovering from the shock of the accident when with little or no warning an acute cellulitis and a general septicæmia develop Slight tension on the stitches, eversion and pallor of the edges and an absence of any but a slight watery discharge are introductory signs. The parts rapidly become very swollen and gas crepitus can be elicited When the wound is reopened a foul smelling serous discharge pours out the subcutaneous tissues are seen to be dirty grey or black and the muscles are swollen, emphysematous and of a dull glazed brick red colour which later changes to green and then black. The skin is at first bright red, but then becomes dusky deep purple and finally black

In the early stages if gas gangrene is suspected but no crepitus can be appreciated, an X ray photograph may be of great assistance as the bubbles of gas are plainly visible in the films

Prognosis in the majority of patients is quite hopeless, unless active treatment is undertaken at the outset There are however less acute cases which respond to local treatment and in which the toxæmia is not severe in these patients temperature is moderately high there are rigors and vomiting and a single group of muscles will be found affected. The toxæmia in fulminating cases is so great that the temperature is subnormal the face pale and haggard the tongue dry brown and furred and vomiting delirium and coma usher in the fatal ending

Gas gangrene more than any other complication of wound in fection serves to point the moral that no ancillary methods will make amends for neglect of meticulous primary surgery

TREATMENT

A **Of the Primary Wound.**—The general principles of immediate wound treatment are laid down on pp 124-126 and a faithful adherence to them will lead to a reduction of clinical gas gangrene to very small proportions

B **Suspected Gangrene.**—If at any time the slightest suspicion of gas infection arises, the wound must be reopened and thoroughly inspected in its every extension. Should no gas be found, nothing more need be done except to powder every surface and recess with penicillin powder pack lightly with vaseline gauze insert no sutures and immobilise in a divided plaster of Paris

C **Of an Established Infection.**—Here we are faced with the problem of conservative surgery or amputation. We can distinguish between four forms or degrees of lesion (*a*) local infection of the wound and its immediate surroundings (*b*) infection of a single muscle or group of muscles (*c*) generalised spreading gas gangrene of the limb and (*d*) a severe infection complicated by compound fracture or division of the main vessels. Clearly the last two demand immediate amputation as a life-saving measure while the first group are ideal for thorough excision and immobilisation It is the second class which gives such anxiety and calls for a nicely balanced judgment Attempts to save the limb may lose a life and some amputations will be performed when excision would have sufficed If the infected muscle can be wholly removed and all damaged tissue excised conservative treatment is justified, the wound being left widely open. It must be followed by the most unremitting attention to every aspect of the patient's condition.

D **Chemotherapy**—Since late 1943 when the second edition of this book was published the value of penicillin in the treatment of gas gangrene has been proved by a mass of evidence from both military and civilian casualties Gas organisms are shown to be highly sensitive to this substance and its importance both as a prophylactic and therapeutic agent has been fully demonstrated. Methods of its use are described in Chap XI

The clostridia of gas gangrene are also sensitive to the sulphonamide drugs which may usefully be administered orally in combination with penicillin therapy

E **Antitoxin.**—The prophylactic use of specific serum rests upon less solid foundations than that in tetanus

In the presence of an established infection large doses of intravenous serum are administered along the same lines as in tetanus, but in view of the success of penicillin, serum therapy will probably be abandoned in this disease in future

In all cases it is necessary to supply ample fluids preferably by the intravenous route Six pints of fluid should be given every twenty four hours this amount including 2 pints of plasma Blood itself is of considerable value in the early stages

The real hope of success in treating this dire infection lies in early and most meticulous surgery to which must be added all possible adjuvant measures. The success of such treatment is well exemplified by the figures for the campaign in Northern Europe (1944-45) in which only 287 cases were reported with a mortality of 22 per cent Reports from other fronts and the civilian hospitals dealing with air raid casualties confirm the success of these methods of treatment

TUBERCULOSIS

ETIOLOGY

Tuberculosis is a chronic infection due to the tubercle bacillus and is responsible for more human deaths than any other disease namely 15 per cent The organism belongs to the group of mycobacteria which on account of their staining reactions in the Ziehl Neelson technique are also known as acid fast bacilli

The bacillus was first discovered by Koch in 1882 It is a slightly curved rod about 4 μ long aerobic, non motile and difficult to stain and culture It is surrounded by a lipoid envelope which accounts for 25 per cent of its weight and for its powers of resistance and long life Four types are recognised, avian, piscine bovine and human of which the first and second are non pathogenic to man.

Although both human and bovine bacilli produce similar lesions stain identically and grow under the same conditions they exhibit considerable differences in their virulence and cultural behaviour and especially in their relationship to their human host On Dorset s egg medium the growth of each is somewhat different and this variation is markedly accentuated by the addition of glycerin to the medium But their differentiation is more strikingly revealed by two biological tests one upon rabbits and the other upon calves If 0 1 c c of a recent culture is injected intravenously into a rabbit the human strain produces scanty and slight lesions whereas bovine bacilli lead to a fatal result within a few weeks Similarly in calves a subcutaneous injection of human bacilli gives a small local reaction, but rapid dis semination all over the body occurs with bovine organisms

Of greater interest however is their relationship to the human being and statistics reveal a remarkable difference in the site of the lesions and the age of the victim. Bovine tuberculosis is rare after the age of 16 years in any part of the body below this age only the cervical and abdominal lymph glands show a higher incidence of bovine over human infection and only bones and joints are attacked in a reasonably high proportion (20 per cent) by the bovine bacilli It is evident therefore that human tuberculosis is preponderantly an infec tion by the human strain of bacillus Infection occurs in three ways by inhalation, ingestion in milk and local invasion via a breach in the skin This last is distinctly rare

MORBID ANATOMY

In the usual mode of infection bacilli enter the lymphatic system and so reach the nearest group of lymphatic glands Here they may be held up or pass on into the venous system and so to the lungs In a massive or virulent infection those that pass through the lungs will reach the systemic system and so become disseminated to distant parts of the body

According to Muir the tissue reaction to the presence of the bacilli varies according to whether the patient is being infected for the first time or reinfected after a previous attack. In the first case the

reaction is proliferative (resembling that to neoplastic cells) rather than inflammatory Epithelioid cells of reticulo-endothelial origin —wandering large mononuclears—become massed around the bacilli, and this group of cells in about two weeks become visible to the naked eye. It is the size of a pin head, transparent and greyish white and is known as a *tubercle*. The fatty envelope of the bacillus acts as a foreign body leading to the production, by fusion of several epithelioid cells of a typical giant cell with anything from twelve to twenty irregularly arranged peripheral nuclei (Fig 9)

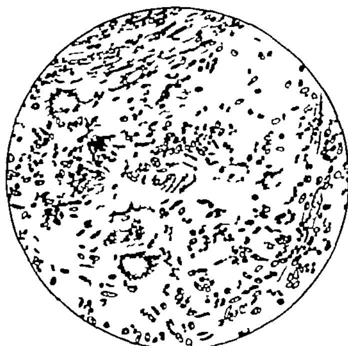


FIG. 9
A microscopic drawing of tuberculous giant cells.

The "tubercle" being avascular soon undergoes a coagulative necrosis from the action of bacterial toxins in the absence of adequate blood supply the result being a central core of dead granular cheesy material ("caseation") which may later when the constituent fatty acids become saturated liquefy to form tuberculous pus a sterile, serous solution containing fatty debris

It is the second or "reinfection type which is usually seen in man, this being inflammatory in character and more rapid in development. There is a typical leucocytic reaction for the first two or three days before the changes enumerated above begin. Lesions in this type tend to break down more readily and each fresh infection produces a higher degree of sensitivity This really an allergic reaction is the basis of the diagnostic von Pirquet and Mantoux tests

A tubercle therefore consists of a central mass of caseous tissue either liquefied or not in which the causative bacilli are seldom found,

surrounded by a circle of giant cells outside which comes the zone of endothelioid cells merging through a small round-celled reaction into normal tissue

The tubercle may fuse with neighbouring foci to produce a clinical tuberculous (cold) abscess It may produce granulation tissue without caseation (the proliferative hypertrophic type seen in the cæcum or joints) it may retain its inflammatory character and spread locally (as seen in the meninges of the brain), or it may lead to a fibrous tissue barrier being formed around itself producing the so-called "healed tubercle These last quite frequently calcify but even so they may contain living bacilli

Spread from a tuberculous focus is by

1 Lymphatic channels
2 Natural passages *e.g* ureter bronchus
3 Permeation, via wandering endothelial cells through neigh bouring tissue spaces and
4 Blood stream either directly as seen in miliary (generalised) tuberculosis or secondarily via lymphatics to venous system

The clinical picture varies from organ to organ and according to the severity of the infection and the resistance of the patient It will be described in detail in considering the diseases of the various parts and structures of the body But it is worthy of note that a definite clinical type (the so-called scrofulous type) of person seems to be more prone to the attack of the tubercle bacillus. Such people are fair haired often rosy of complexion, commonly freckled with long eyelashes and fine features and frequently mentally precocious.

Only principles of treatment can be mentioned here The first and greatest is rest Every effort should be made to raise the patient s own power of resistance by good food, tonics fresh air and sunlight. Any secondary septic foci must be adequately dealt with Counter irritants may be used or injections of tuberculin given. This latter treatment is of particular service in genito-urinary tuberculosis Surgery may be required to secure mechanical rest to an affected part or organ, to excise or even amputate a localised lesion, to curette and cauterise tuberculous foci and to aspirate abscesses

Since the discovery of penicillin much research has been directed to other moulds from one of which Streptomycin has been produced. Many encouraging results have been obtained from the use of this substance but it is by no means devoid of serious complications (Chap XI)

Tuberculosis is an infectious and notifiable disease

LEPROSY

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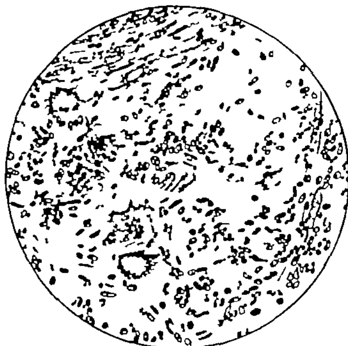


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As well as the local effect viz the production of a tough adherent, whitish membrane the bacilli manufacture an exotoxin which in the blood stream leads to generalised changes particularly in muscles (including the heart) and nerves Hence post-diphtheritic paralysis may occur and require suitable treatment (see Chap XLIII) The muscles most frequently affected apart from the heart are the ocular palatal and extensors of forearm and wrist

It is interesting that babies are immune to diphtheria, the highest incidence occurring between the ages of 2 and 5 Some individuals are carriers of diphtheria bacilli without themselves being affected. Immunisation of all children should be made compulsory

Treatment is by the specific antitoxin, which is given in doses of from 10 000 to 50 000 units and may be repeated once or twice as indicated.

GLANDERS

Glanders is a rare disease in man It is caused by the *B mallei* and affects chiefly the horse in which it presents both acute and chronic forms. As it is contagious man is secondarily infected via some abrasion of skin or mucosa on exposed parts and the disease is always acute It is usually initiated by contact with the nasal discharge from an infected horse

The *B mallei* in many respects resembles the tubercle bacillus It is a slender gram negative rod, difficult to stain except by carbol fuchsin and best cultured on potato when it produces a characteristic yellow growth which later darkens to a chocolate tint

Clinically there is an incubation period varying from two to three days to as many weeks—usually the former The first signs are catarrhal inflammation of mucosa of mouth and nose together with the appearance of papular skin nodules These develop rapidly into a crop of pustules which break down to form a ring of irregular ecthymatous ulcers the floors of which are covered by unhealthy slough and from which comes a foul blood-stained and infective discharge Pathologically the lesion is an atypical infective granuloma.

Neighbouring glands are enlarged and tender and constitutional symptoms soon make their appearance Pains in bones from osteo-periostitis are the most frequent symptoms and may be the first signs of the onset of the disease Actual metastases occur and produce nodules in lungs liver spleen and kidneys. Muscular abscesses and venous thrombosis are common.

The mortality is very high, two out of three cases proving fatal.

The chronic form is seen only in the horse This affects chiefly the lymphatic system giving rise to what are called farcy pipes" and farcy buds

A vaccine termed mallein has been used both for diagnosis and treatment but its effects are so marked that it is really dangerous Diagnosis can be established by injecting some of the suspected material from a skin lesion into the peritoneum of a guinea pig In

positive cases there is within twenty four hours an acute inflammation of the tunica vaginalis (Strauss reaction) and fluid from this contains masses of bacilli which give a typical growth on potato

Treatment is purely symptomatic Excision is the ideal if the disease is recognised early enough otherwise opening and curetting of the abscesses offers the best hope This of course is combined with suitable measures to enhance the patient s general resistance

PLAGUE

PLAGUE is due to *B pestis* first discovered in 1894 The disease which is now seen practically only in Asia apart from sporadic cases is transmitted by one species of rat-flea (Cheops) and flourishes in conditions of poor sanitation There is an incubation period of four to five days, the onset being accompanied by high temperature headache and often epistaxis Lymphatic glands (inguinal and axillary) enlarge in the bubonic type and occasionally suppurate The skin is covered with petechial spots (plague spots) Four out of five cases die More severe forms are termed pneumonic and septicaemic and are invariably fatal. Buboes may need incision Inoculation with vaccine (Haffkine s) has been reported to do good

RABIES

This is a dire disease caused by a filter passing virus introduced into the victim by the bite of a mad dog Infection has also been known to come from wolves horses cats pigs and even birds It is most commonly seen to-day in India The tragedy of the disease lies in the length of its incubation period What seems and is treated as a trivial injury at the time may lead, months later to a fatal issue The incubation may be as short as twelve hours is much more usually six weeks to two months and may be more than a year

The clinical picture develops insidiously with feelings of malaise chilliness and probably an aching in the original wound Giddiness and a subjective feeling of terror follow and then appear the typical clonic rhythmical spasms affecting chiefly the muscles of deglutition and respiration. The fear of initiating a spasm accounts for the refusal to take liquids (hence the synonym hydrophobia) and the constant salivation. The temperature rises to great heights the pulse becomes rapid and irregular dyspnoea and hiccough supervene the urine is loaded with albumen and a pre-terminal period of delusions amounting to mania lead within two to four days to a fatal issue Post mortem examination shows very little there being an occasional vascular thrombosis in the medulla sometimes degenerative changes in the ganglion cells of the cranial nerves especially the vagus and usually the presence of the so-called Negri bodies in the hippocampus and cortex.

Treatment is chiefly prophylactic A suspected wound should be allowed to bleed freely and cauterised venous circulation to the limb

being blocked as quickly as possible Pasteur's vaccine made from an attenuated virus is the great specific and is effective for at least six months Once the condition has developed treatment is only symptomatic. Massive doses of morphia are indicated and rectal feeding must be instituted.

GLANDULAR FEVER

Infective Mononucleosis is an acute infection, the origin of which remains in doubt though there are some grounds for regarding it as a virus disease It is characterised by pyrexia a sore throat which may be sufficiently acute to resemble Vincent's angina a swelling of the spleen and lymph glands particularly in the neck. The blood picture shows a white cell count between 15 000 and 40 000 in which from 40 to 80 per cent of cells are mononuclear lymphocytes In addition the patient's blood serum develops an agglutinin to sheep's red blood corpuscles (Paul Bunnel test) These cases present problems in diagnosis but general treatment leads to a speedy recovery

INFECTIONS DUE TO INTESTINAL BACILLI

B. COLI

The *B coli communis* is a normal inhabitant of the intestinal canal. It is a gram-negative motile organism with three to six flagellæ it grows easily and produces gas and thin pus which by itself is odourless It is only when the bacillus deserts the lumen of the in testine that it becomes pathogenic This however is very frequent and it is the commonest secondary infection in inflammations of the intestinal canal *e.g.*, appendicitis It is also a frequent etiological agent in such diseases as cholecystitis, pyelitis ischiorectal abscesses, etc

B. PROTEUS

This is commonly found in the company of *B coli* and, like it is only pathogenic outside its natural habitat—the intestinal canal It is usually present in appendicitis many infections of the lower urinary tract and abscesses secondary to spread of inflammation from the gut It is responsible for the particularly foul odour of so-called fæcal pus "

B. TYPHOSUS

This organism is responsible for typhoid fever It is a short gram negative bacillus with anything up to twenty flagellæ motile but unlike *B coli* produces no gas in culture The chief means of differ entiating it from similar organisms depend on the fact that it produces specific agglutinins in the patient's blood —this being the basis of the diagnostic Widal reaction

Infection is usually via polluted water but food, soil and direct contact are other less common sources The organisms in the typical case reach the lymphoid patches of the lower ileum where they set up an inflammation which leads to mucosal ulceration and sometimes to severe intestinal hæmorrhage or perforation The initial clinical

picture consists of headache malaise epistaxis increasing pyrexia, and the appearance of a characteristic roso-red rash. Another complication of surgical importance is the occurrence of thrombophlebitis either in the pelvic or femoral veins

Detailed accounts of the disease and its treatment will be found in textbooks of medicine but from the *surgical viewpoint it should* be remembered that the bacilli may be the etiological agent in cholecystitis arthritis and osteomyelitis

DYSENTERY

Bacillary dysentery is due to infection from contaminated water food etc. by the Shiga and Flexner bacilli Both these types are gram negative and non motile They are found during the disease in the *intestinal wall neighbouring glands and liver* The clinical picture is dominated by the excessive and continual diarrhœa which leads to marked dehydration and may be accompanied by severe hæmorrhage

Ulceration of the intestinal mucosa takes place and the ultimate result of this may bring the case into the sphere of the surgeon by perforation and subsequent peritonitis stricture formation and secondary intestinal obstruction or a disseminated infection seen in joints and bones

In tropical countries an acute attack of dysentery may closely simulate acute appendicitis In rare cases dysentery bacilli may be the principal pathogens in a true appendicitis

B. PYOCYANEUS

This is a normal inhabitant of the intestinal canal, but not usually present to any great extent Occasionally its presence can be recognised by the peculiar blue-green colour of the pus it produces When found in sufficient quantity to be easily recognised the prognosis of the case is correspondingly worse It is a motile flagellate gram negative organism

It may be seen every now and again in the discharge from a chronic bone sinus. It is highly susceptible to streptomycin

INFECTIONS DUE TO COCCI

ERYSIPELAS

Erysipelas, known many years ago under the more picturesque name of St Anthony's Fire or "Rose is an infection of the epidermis or mucosa with a hæmolytic streptococcus (*S erysipelatus*) The acute inflammation so produced is in many respects similar to cellulitis but effects more superficial layers Combined types are often seen (*cellulocutaneous erysipelas*) *especially in lax tissue* such as the eyelid or scrotum The infecting organism obtains entry by some break in the surface epithelium though this may be so small as to be invisible

Ninety per cent of cases occur in the face or scalp (Facial or

Idiopathic type) the arms and hands account for most of the remaining 10 per cent more uncommon but noteworthy sites are the umbilical cord (E. neonatorum) operation wounds scrotum mucosa of mouth, pharynx and larynx and vagina (puerperal F)

Clinically there is an incubation period varying from twelve hours to three days before the appearance of the typical rash This is accompanied by marked general signs of fever due to the absorption of virulent toxins. Vague pains and headache are rapidly followed by rigors occasional vomiting and a high temperature (103 to 105 F) The pulse is full and over 100 the tongue furred thirst is complained of and anorexia, constipation albuminuria and delirium complete a typical picture. The blood shows a marked leucocytosis

Locally the rash is vivid red in colour and fades on pressure. The advancing edge which is irregular raised and clearly defined shows all the signs of acute inflammation just beyond it the skin lymphatics are crowded with streptococci which induce a characteristic and marked lymphocytic reaction. As the rash spreads which it does fitfully the centre of the affected area quickly fades but remains shiny Pain is conspicuous by its absence and pus is never formed

Occasionally vesicles and bullæ are seen and as the infection dies down the skin desquamates fine scales being shed These scales and the occasional watery discharge from skin blebs are the *only* infectious elements in the disease It is thus really only contagious but for this reason is a notifiable disease Glands draining the affected area are usually enlarged and may rarely break down and form abscesses

Spontaneous recovery takes place in two to three weeks, but relapses are common. The mortality is about 5 per cent

Treatment.—Patients must be strictly isolated to prevent the infection spreading Treatment has been revolutionised by penicillin and the sulphonamide drugs which control the disease within a few hours.

The peculiarly beneficial effect of an attack of erysipelas on co-existent chronic infections (*e.g.*, chronic ulceration and eczema particularly of tuberculous or syphilitic origin) and on certain types of neoplasm has long been noted and has led to the treatment of sarcomata by a bacterial emulsion containing *Streptococcus erysipelatis* (Coley s Fluid)

PNEUMOCOCCUS

This is a gram positive encapsuled diplococcus, usually found outside the cells of the organ or tissue affected and lanceolate in shape It shows a marked propensity to attack serous membranes and hence apart from being the chief causal agent in lobar pneumonia it can produce pleurisy (empyema) peritonitis meningitis pericarditis, arthritis otitis etc Any of these infections may be sufficiently severe to lead to a widespread dissemination by the blood stream and a definite septicæmia

Its pus is typically greenish white in colour and curdy in consistency

Clinical signs and treatment are considered in descriptions of the various organs concerned (*q v*).

INFECTIONS DUE TO SPIROCHÆTES

SYPHILIS

The various clinical manifestations resulting from infection with the *Spironema pallida* and their treatment are dealt with elsewhere (Chap X)

YAWS

YAWS (Framboesia Tropica) —A chronic granulomatous disease due to *Spirochaeta pertenuis* It is characterised by ulcerating nodules, usually single always painful and affecting the face in the majority of cases The average incubation period is about two months The disease is contagious, but unlike syphilis there is no hereditary transmission. Again, mercury and iodides have no effect whatsoever but the reaction to either intravenous arsenic or intramuscular sodium potassium bismuth tartrate is magical Two treatments will probably cause the lesion to heal although residual scarring is marked and unsightly

DISEASES DUE TO FUNGI

ACTINOMYCOSIS

Bacteriology—This infection is different to any that we have previously described The causative organisms—*Streptothrix actinomyces*—belong to higher groups of bacteria a characteristic of which is that they appear in long hyphal threads instead of single units although under certain conditions they may assume a bacillary form These actinomyces resemble fungi in that they grow in similar filamentous branching threads (mycelium) Certain species produce a specialised type of cell upon culture media (but never in the human body) named conidia These are not true spores though in suitable cultural conditions they will develop into mycelium



FIG 11

An actinomycotic colony showing the mycelial threads in the centre and the clubs at the periphery

In man the streptothrix can best be examined by taking a sulphur yellow granule from the discharge from a sinus. Teased out and examined microscopically it will show a tangled mass of mycelial threads at the periphery of which are grouped a series of thickened radiating outgrowths known as "clubs" These are not spores but the swollen ends of mycelial threads which are regarded as a defensive mechanism on the part of the colony they are never found upon culture This radiating club-like pallisade is responsible for the name given to these colonies—the *ray fungus* (Fig 11)

TRICHINOSIS

Infection occurs by the ingestion of meat usually pork contaminated with the small round worm—*Trichina spiralis* The worm escapes from the alimentary canal and is carried by the blood stream to various parts of the body For some unexplained reason the muscles are usually the favoured site particularly those of the shoulder girdle (trapezius and deltoid) Here the worm settles down becoming encapsuled and very often ultimately calcified The blood-stream infection is marked by a feeling of malaise and perhaps slight fever Within a day or two the affected muscles become tender and swollen. If as is often the case incision is made on the supposition that the condition is an acute infection the muscle will exude a clear serum often containing worms These can be seen naked-eye in the muscles as small white dots After the acute stage the disease is symptomless, although patients are prone to occasional attacks of urticaria Santonin is a specific for the worm in the alimentary tract

CYSTICERCOSIS

This is the name given to the intermediate or cystic stage in the life-history of the *T solium* This stage usually occurs in the pig (measly pork) but man is occasionally affected indirectly and very rarely directly The cysts become surrounded by fibrous tissue and frequently calcify Any organ may be affected and any clinical signs produced are those due to the presence of the calcified cyst *e.g* in the lung eye or brain. Treatment is excision

BILHARZIA

This disease is due to a parasite called the *Schistosoma hæmatobium*—one of the trematode worms. Its life-history is as follows The ova are shed in human fæces or urine If they reach water in the process their capsule is dissolved and a freely swimming embryo (miracidium) emerges This has a life of about thirty-six hours, and if during that time it is ingested by a particular type of water-snail it lives in its digestive gland and continues to develop into a sporocyte This in about six weeks becomes filled with the primitive worms (cercaria) characterised by a forked tail and two suckers These are voided by the snail and can live for thirty-six hours in the surrounding water If during this period they enter the human stomach in drinking water they lose their tails burrow through into the portal system radicles and develop into adult worms in about six weeks The female of the species then swims against the blood stream to either the rectal or vesical mucous membrane (more rarely stomach vulva skin, lungs and intestine are affected) from which the ova are shed so completing the cycle It is these ova which produce the clinical picture of the disease They are about 1 mm in length and vary in shape according to their habitat the vesical type having a terminal spine the rectal a lateral one Their presence in the submucosa is most irritating and leads to the production of masses of soft granulation tissue which project into the rectum or bladder and bleed

easily Hence frequency tenesmus hæmaturia or bleeding per rectum and anæmia are the predominant signs

Treatment by intravenous antimony tartrate is specific (Dose gr ⅛ increased by gr ⅛ daily until gr ii is reached this amount being given every second day until a total of gr xxx has been reached.)

FILARIASIS

The Filaria bancrofti is a very fine round worm some 3 in long which lives in and blocks lymphatic channels especially in the region of the groin These worms give off countless embryos which make their way to the blood stream from which they are sucked by mosquitoes and so re-injected into another man The embryos about 0·01 in. in length migrate at night and hence are known as *F nocturna*

Its effect and the clinical picture produced are described in full on p 299

GUINEA WORM

It is the female of the species (*Dracunculus medinensis*) which is responsible for the clinical picture The worm reaches the human being by being swallowed in polluted water It is yellowish white in colour and when fully grown may be as long as 18 in. About a year after ingestion it burrows its way to the surface usually in the feet or legs for the purpose of shedding its eggs once more Its arrival at the surface is heralded by the appearance of a painful red swelling which ultimately breaks down, leaving an ulcer from the centre of which eggs are discharged.

It is only at this stage that the worm can be captured. Bathing in very cold water will make it visible and it is then very slowly withdrawn—a process that may take over a week.

AMŒBIC INFECTIONS

The only one of importance in man is that of the *Entamœba histolytica* the cause of amœbic dysentery The typical lesion in this disease is an ulcerative colitis (see Chap XXIX) The possible sequelæ of intestinal strictures and obstruction should be noted. An important secondary site of infection is the liver (or more rarely lung and kidney) where the so-called tropical abscess develops (see Chap XXXIII)

Emetine (gr 1 daily) subcutaneously is specific and most efficacious in the earlier stages

INSECT INFECTIONS

CHIGOE is the name given to a condition, chiefly affecting the toes and scrotum of children in tropical climes due to the irritation of the eggs of sand fleas

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CHAPTER V

VENEREAL DISEASES

GONORRHŒA

Gonorrhœa is a contagious disease usually limited to the urinary and genital organs the causative organism being a specific diplococcus first demonstrated by Neisser in 1879 The gonococcus is almost invariably diplococcal, the cocci of each pair being flattened on their adjacent surfaces which never appear to be in contact Multiplication takes place simultaneously in each pair and a consequent tetrad form is often apparent. They are readily ingested by polymorphonuclear leucocytes and are usually found to be intracellular in stained smears They stain with most basic aniline dyes are Gram-negative and can be cultivated on suitable media.

Transmission of the disease among adults is by venereal means though in women and female children an infected towel or lavatory seat may very rarely be responsible

GONORRHŒA IN THE MALE

In two to ten days after an infected coitus the patient is aware of an irritation at the end of the penis and a little discomfort on micturition. Inspection shows the meatus to be somewhat inflamed and a little sero-purulent discharge can be expressed In the course of a day or two this discharge becomes thicker and more abundant and as the inflammatory process spreads backward into the posterior urethra, local irritation may cause frequency of micturition and painful erections of the penis known as chordee

After about ten days the acute inflammation begins to subside the pain and discomfort passing off and the discharge though persisting becoming thinner and less abundant The discharge finally disappears at any time between three and ten weeks or a small drop of muco-pus may continue to be seen on rising in the morning As long as there is the slightest visible discharge it is certain that the patient is not cured, and even when this is absent there is always the possibility that gonococcal colonisation is continuing in the submucous tissue of the urethra or in its adnexa

In order that the nature and possibilities of gonorrhœa in the male be appreciated, the anatomy of the genital organs must be borne in mind. Examination of the mucous membrane of the anterior urethra *i.e.*, that part in front of the anterior layer of the triangular ligament,

reveals the openings of numerous mucous glands The larger ones are known as Littré's glands while in the floor of the bulbous portion of the anterior urethra are the openings of the two ducts of Cowper's glands The posterior urethra contains a few rudimentary Littré's glands the verumontanum with its prostatic utricle and on each side of it the openings of the tubular glands of the prostate and of the common ejaculatory ducts leading from the seminal vesicles

All these structures are liable to invasion by the gonococcus and once it has taken up its abode in such inaccessible situations it may prove difficult to dislodge It is fortunate that nature plays a predominant part in the treatment of gonorrhoea and provided that free drainage is effected a large number of cases proceed to spontaneous cure without serious complications. The gonococcus in addition to infecting these glands possesses the power of penetrating the unbroken mucous membrane and colonising in the submucous tissue

Methods of Diagnosis.—Urethral discharges are not always gonococcal urethral calculi Bacillus coli infections chemical prophylactics and contraceptives trichomonas infestation, sugar laden urine oxalate crystals instrumentation without strict aseptic precautions and the use of too strong antiseptic irrigations are all capable of setting up a purulent urethritis In the acute stage of gonorrhoea a thin smear of the discharge is stained by Gram's method and large numbers of Gram negative diplococci lying within the pus cells will be seen In subacute and chronic cases the pus may be scanty or non-existent and the gonococci few in number and in these cases every part of the urogenital apparatus must be examined The prostate and vesicles are palpated per rectum and prostatic secretion is expressed and collected on a slide and culture medium for examination Cowper's glands which are impalpable when normal are sought for between the forefinger in the rectum and the thumb on the perineum the epididymis and spermatic cord are examined for thickening and finally the urethra is inspected through the urethroscope If any doubt remains a complement fixation test should be carried out as a positive result in the absence of recent vaccine treatment is generally indicative of the presence of the gonococcus

Treatment in all stages of the disease is governed by four principles viz. (1) free drainage of all infected parts must be ensured (2) the resistance of all tissues both local and general, to the gonococcus is to be encouraged (3) the patient must be prevented from doing anything which will interfere with the natural cure (4) penicillin and sulphonamides

PENICILLIN —Large-scale trials in the British and American Forces during the war have shown that a very large majority of all gonococcal infections can be clinically and bacteriologically cured by *penicillin* within a very short time and that most of such few cases as do relapse are cured by retreatment with larger doses. A minimum total dosage of 150 000 units is usually necessary and optimum results follow five intramuscular injections of 30 000 units at two-hour intervals as this method of treatment is inconvenient for out patients fewer larger and less frequent doses may be given and comparable results appear to

follow three injections of 50 000 units at four hour intervals. As aqueous solutions of penicillin are quickly excreted and the blood level rapidly falls its absorption may be delayed and its action prolonged by suspending the drug in oily preparations e.g 4 per cent beeswax in peanut oil and already a large number of cures have followed single injections of from 100 000 to 300 000 units suspended in such a compound.

Procaine penicillin in oil with 2 per cent. aluminium monostearate is now extensively used a single injection of from 150 000 to 300 000 units giving excellent results in over 90 per cent of uncomplicated cases

When treating gonorrhœa with penicillin, it must be remembered that the drug is strongly spirochæticidal and that in cases of concurrent syphilitic infection still in the incubation period the appearance of the primary sore may be delayed if too large a dose is used. For this reason it is advisable that the total dosage for early uncomplicated cases should not exceed 300 000 units, and that a blood test for syphilis be done three and six months after treatment to ensure that the signs of the more serious disease have not been masked.

Toxic effects after penicillin are almost non-existent though mild urticaria very occasionally occurs about a week after treatment

SULPHONAMIDES —If penicillin is not available fair results may be obtained with sulphonamides, provided that the strain of gonococci is not sulphonamide-resistant In order to achieve an adequate concentration in the blood stream the dose should be high and medication should preferably be carried out six hourly day and night The tablets should be crushed before they are taken and washed down with a minimum of half a pint of water In the vast majority of cases urethral irrigation is unnecessary adequate drainage being maintained by an increased fluid intake with a consequent over production of urine The following course of treatment is recommended for an otherwise healthy male of average weight First two days, 2 grm. at once thereafter 1 grm six hourly third to fifth days 1 grm six hourly total dosage 24 grm.

Seven days after the end of treatment provided that there is no discharge and the urine is clear a specimen of the prostatic secretion is obtained by massage per rectum and examined microscopically for pus cells and organisms If this is normal the patient is examined weekly for four weeks and monthly for a further two months when if there has been no recurrence of discharge and the urine remains clear and free from threads test of cure can be commenced.

Both sulphathiazole and sulphadiazine have a decided tendency to crystallise in the urine occasionally causing blockage of the tubules of the kidney and of the ureters and a daily fluid intake of at least 5 pints is necessary during their administration

It is important to remember that whether penicillin or a sulphonamide drug is used its effects should be apparent after forty-eight hours treatment, and if by this time the discharge has not considerably diminished and the urine commenced to clear it should be stopped at once and the cause of the failure investigated

Failures are usually due to one of the following reasons —

1 Drainage is inadequate
2 The patient s immunity response to the infection is subnormal
3 The sulphonamide drug is not being absorbed in adequate amounts from the intestinal tract or
4 The infecting organism is sulphonamide-resistant due to previous inadequate dosage which has accustomed it to the drug or to infection with a drug fast strain of gonococcus
5 It is also possible that some strains of gonococci may be penicillin resistant but this has not yet been established.



Fig. 12
Rash following sulphapyridine therapy

A combination of the first two reasons will often explain the failure of sulphonamide therapy and penicillin should be given without delay in all such cases

Minor toxic effects occasionally occur during or shortly after treatment with sulphathiazole or sulphadiazine These include headache nausea giddiness dyspnoea and skin rashes of an urticarial type The skin eruptions (Fig 12) are sometimes severe and nearly always commence eight or nine days after the start of the treatment they sometimes resemble erythema nodosum and are confined to the skin covering

the front of the legs If the drug has not already been stopped this should be done at once and if the rash persists for more than forty-eight hours a differential white cell count should be carried out Dangerous toxic effects are rare and among those that have been described are severe dermatitis, sulphæmoglobinæmia aplastic anæmia agranulocytosis and hæmaturia due to crystallisation of the drug in the renal tubules An adequate fluid intake will almost certainly ensure against this last complication if the kidneys are healthy and the recommended dosage is not exceeded In view of the possibility of these side effects these drugs should only be used under close medical supervision and facilities for blood counts should constantly be available It appears to be quite unnecessary to forbid foods rich in sulphur such as eggs and onions though it is probably wiser to rely on purgatives other than sulphates

Complications are due to a variety of causes chief among which is delay in commencing treatment They consist in infection of the urethral adnexa or of the urogenital system and in metastatic blood borne infections

A THOSE FROM THE ANTERIOR URETHRA.—1 *Periurethral abscess results from the infection without free drainage of a Littré s gland* which proceeds to suppuration. A very painful swelling which later becomes fluctuant appears on the lower surface of the penis The abscess should be incised when definite fluctuation is felt the cavity being lightly packed with paraffin and flavine gauze Great care must be taken not to incise the urethra as if this is done a urinary fistula will undoubtedly follow

2 *Chronic littritis* or persistent infection of Littré s glands is diagnosed by palpation of the urethra upon a straight metal bougie when indurations varying in size from a millet seed to a split pea may be felt in the urethral wall Treatment will consist in massage of the urethra upon a straight sound being followed by urethral irrigation to wash away the infected matter expressed.

3 Either of *Cowper s glands* may be the seat of an abscess which leads to acute pain in the perineum when the compressor muscle contracts at the end of micturition The abscess may point in the perineum where it should be incised Chronic infection occasionally occurs in which the enlarged gland can be felt within the compressor urethræ muscle between a finger in the rectum and a thumb on the perineum Bi weekly massage followed by urethral irrigation will aid drainage and assist resolution. In persistent cases however the gland should be excised.

4 *Stricture of the urethra* is often a late sequel of submucous infection Its clinical picture and treatment are described on p 826

B THOSE FROM THE POSTERIOR URETHRA —1 *Hyper-acute posterior urethritis* gives rise to painful frequency strangury and often terminal hæmaturia. Treatment consists in rest in bed, frequent hot hip baths and the administration of an alkaline mixture containing tincture of hyoscyamus with potassium citrate

2. *Acute prostatitis* is a common complication and occasionally goes on to suppuration Retention of urine and acute rectal pain are

present and the hot enlarged and excruciatingly tender prostate can be felt per rectum The condition is treated by rest in bed hot enemata and frequent hot baths the patient being encouraged to micturate while in the bath If the retention persists the urethra is anæsthetised with 2 per cent novocain and a soft rubber catheter passed The abscess usually bursts into the urethra and as soon as the acute tenderness has subsided drainage is assisted by gentle massage per rectum

3 *Chronic prostatitis* is the commonest cause of long-standing infection It may give rise to no symptoms but many patients complain of vague unpleasant sensations in the perineum and short threads of muco-pus are present in the morning urine On rectal examination the gland is found to be enlarged in one or both lobes is tender to palpation and may contain nodules in its substance The prostatic secretion should be expressed by massage after irrigation of the urethra, and the presence of pus cells and organisms will confirm the diagnosis Chronic prostatitis is frequently kept up by secondary pyogenic infection, and gonococci are rarely found in long-standing cases Local treatment consists in bi weekly massage of the gland to assist drainage followed by immediate irrigation of the urethra to prevent its re infection If the urine is free from pus a full sized sound may be passed with advantage before massage to stretch the openings of the prostatic and ejaculatory ducts and so facilitate drainage Diathermy to the prostate may assist in clearing up the infection

4 *Acute vesiculitis* is rare It is characterised by painful blood-stained nocturnal emissions the enlarged and tender vesicle being felt per rectum. Operative treatment may be necessary if drainage is unsatisfactory

5 *Chronic vesiculitis* may follow an acute attack or may be chronic from the beginning and is treated by bi weekly massage of the vesicles per rectum If this fails an attempt may be made to sterilise the vesicle by the injection into it through the vas of a 1 100 solution of argyrol (Belfield s operation)

6 *Acute epididymitis* results from the spread of the infection along the vas or its lymphatics There is usually pain, tenderness and enlargement of the vas in the inguinal canal and later the epididymis swells up and a condition of epididymo-orchitis follows The pain is severe and there are sometimes marked constitutional disturbances while the urethral discharge often temporarily ceases Treatment includes rest in bed with local applications to the scrotum of glycerin and belladonna or unguentum hydrarg co Resolution usually starts within ten days but recurrences are not uncommon if irrigation is resumed at too early a date Bilateral cases are apt to be followed by sterility

7 *Acute cystitis and pyelitis* are very rare complications

As a general rule penicillin should be given in all complicated cases of gonorrhœa Much larger doses are usually necessary and should be in the order of 600 000 units daily for at least four days

C EXTRA URETHRAL CONTACT INFECTIONS —*Gonorrhœal Ophthalmia* in newly born infants is a well known condition and needs no

description here It is occasionally seen in adults in whom it is usu carried by the fingers to the eye The first symptom is an a conjunctivitis which if not promptly treated spreads to the co and eventually a pan-ophthalmitis results Treatment consists immediate local and parenteral penicillin therapy and protecting other eye with a Buller s shield The advice of an ophthalmic surg should be sought without delay

Gonorrhœal Proctitis in males is the result of unnatural se relations. It is treated with penicillin and/or sulphonamides and irrigating the rectum with 1 6000 potassium permanganate i usually easily cured.

Papillomata of the glans penis or prepuce are not infreque present during an attack of gonorrhœa but often occur in the abs of a gonococcal infection especially in patients of uncleanly ha Consequently the terms venereal or gonorrhœal warts should neve used. The accompanying balanitis should first be treated with pero of hydrogen and when this has been controlled the warty grow can be removed with the electric cautery Good results also follow pa ing the warts with a solution of 25 per cent podophyllin resi spirit

D Metastatic Complications —Infection of the blood is not common and the organism has been cultivated from the blood uncomplicated cases of urethritis The parts most commonly attac are the joints (knee wrist elbow) bursæ (subdeltoid) tendon shea (in the hand peroneal) and fascial planes (the plantar ligame of the sole of the foot) These conditions are characterised by sudden onset of acute pain in the affected part which often oc when the patient is in bed at night Signs of acute inflammation generally present but suppuration rarely follows These proce are described in other sections of this book. The treatment cons in eradicating the primary focus of infection which is usually in prostate

Metastatic iritis is occasionally seen and is accompanied by so conjunctivitis Resolution often takes place if the primary focu treated, but the immediate instillation of atropine is essential for prevention of adhesions Gonococcal septicæmia and pyæmia very serious but very rare while endocarditis is still more rare an almost invariably fatal

Subacute and chronic metastatic infections are sometimes resistan penicillin chemotherapy and focal treatment and in these cases artific fever therapy will frequently achieve a cure The body temperat is raised either by the intravenous injection of T.A.B vaccine (init dose 25 millions) or by means of the Kettering hypertherm. This is insulated air-conditioned cabinet in which the patient is placed in which the dry bulb temperature and the relative humidity thermostatically controlled the patient s body temperature be continually ascertained from an external indicator connected w a rectal thermometer A complete systemic examination sho always be carried out before these methods of treatment are embar upon

Tests of Cure should always be rigorous They should include a thorough examination of the urethral adnexa and the prostatic fluid must in every case be subjected to microscopic examination A full-sized bougie (Clutton s 20/24) is passed and the urethra carefully palpated upon it The complement fixation test may be done but often never becomes positive in penicillin or sulphonamide treated cases Any recurrence of symptoms the reappearance of threads in the urine or of pus cells and organisms in the prostatic secretion indicate that the disease is not cured.

Keratoderma Blenorrhagica.—The so-called gonococcal hyper keratosis which also may occur with non-gonococcal urethral infections is rare and though when it occurs it always accompanies a urethritis with metastatic complications evidence of gonococcal infection is sometimes not forthcoming The condition which is found in men only consists of a vesi cular eruption in which the walls of the vesicles become keratinised The resulting crusts eventually separate leaving a red, moist area of skin The condition is most often confined to the toes and soles of the feet (Fig 13) though it is very occasionally seen on the legs, penis, hands and trunk. The presence of the lesion indicates a poor immunity response to the infection and is an indication for hyperthermic treatment No local treatment is necessary except for strict cleanliness of the affected parts



FIG 13

Keratoderma blenorrhagica.

Non-gonococcal Urethritis.—About 30 per cent of all cases of urethritis are non-gonococcal though often venereal in origin and on this account it is essential that all urethral discharges be subjected to a careful microscopic examination before treatment is commenced. The causes of this condition are legion and may be divided into two main classes chemical and infective Chemical prophylactics instilled into the urethra contraceptive ointments and pessaries used by the female glycosuria and oxaluria are examples of the former They are usually rapidly cured by removal of the cause and by an increased fluid intake which will produce a flow of bland non irritating urine Primary non-gonococcal infection of the urethra is commoner than was previously supposed though many of the so-called cases are secondary to a feeding focus in the prostate or vesicles, the residuum of long standing post-gonococcal secondary infection. Provided however that the history excludes a chemical etiology that there is no previous history of gonorrhoea and that the prostate can be exonerated bacterio logical examination of the discharge will sometimes reveal the causative organism though only too often the flora will be so varied that it is impossible to determine which variety is to blame Coliform organisms staphylococci, streptococci of the faecalis type and diphtheroids are

usual and occasionally the *Trichomonas vaginalis* a protozoon well known as a cause of vaginitis in women may be present In cases where coliform organisms predominate in the smear a midstream specimen of the urine should always be cultured, as a urethral discharge is not infrequently seen in pyelitis or cystitis due to this group Though pure coliform infections react well to sulphonamides those due to other bacteria are often unaffected by any form of chemotherapy and are best treated by daily irrigation of the urethra with a warm solution of oxycyanide of mercury (1 10 000) which may be followed by an instillation of a freshly prepared 5 per cent solution of protargol the latter being retained in the anterior urethra for five minutes

Many cases of non-gonococcal urethritis react well to streptomycin and this anti biotic should always be tried in cases which fail to respond to sulphonamides Daily injections of 0 5 to 1·0 grm. should be given for not longer than five days

It must be remembered that metastatic manifestations such as arthritis fasciitis and iritis can be caused by a non-gonococcal urethritis or prostatitis and a diagnosis of gonorrhœal infection must never be made without bacteriological or serological evidence

Trichomonas infestation of the urethra is unaffected by penicillin sulphonamides or by local treatment but reacts well to urethro-vesical irrigations with oxycyanide of mercury (1 10 000)

GONORRHŒA IN THE FEMALE

In women the gonococcus usually attacks both the urethra and the cervix uteri, though occasionally the infection may be limited to one of these sites. The early symptoms tend to be much less severe than in the male there often being no pain on micturition and the patient regards the discharge as an attack of leucorrhœa (the whites ') Hyperacute forms are known in which the discharge is profuse and the vulva is œdematous and inflamed.

Treatment.—Local treatment should be confined to a daily vaginal douche with a weak solution of bicarbonate of soda or permanganate of potash caustic preparations or strong antiseptic solutions during the acute stage being both futile and dangerous

Chemotherapy —Penicillin gives equally good results in female as in male cases and the gonococci quickly and permanently disappear from the urethral and cervical secretions Often, however a resistant infection of the cervix with secondary organisms which may need active and prolonged local treatment persists This is the result of the inflamed endocervix becoming infected with vaginal organisms which are not affected by penicillin or the sulphonamides and which normally do not have the power of penetrating unbroken mucous membrane and it is good practice to sterilise the vagina by insufflation with stovarsol powder if the cervical inflammation does not rapidly clear up A daily vaginal douche followed by a thorough dry swabbing of the vagina should always precede each insufflation as occasionally large

enough quantities of arsenic are absorbed as to cause arsenical dermatitis

Complications.—Persistent urethritis will sometimes be found to be due to an infection of Skene's tubules These are two small blind ducts opening on to the floor of the urethra just within the meatus They are best treated by injecting into them through a blunt hypodermic needle a few drops of a 5 per cent silver nitrate solution or by obliterating them with the electric cautery

BARTHOLIN ABSCESS —The ducts of Bartholin's glands are often infected and suppuration commonly occurs Treatment consists in aspiration or incision This should always be done before commencing treatment with penicillin or sulphonamides Chronic Bartholinitis is best dealt with by complete excision

ACUTE SALPINGITIS is fully described in Chap XXXIX

PROCTITIS is a common complication the rectum being infected by the vaginal discharge A proctoscope should always be passed on all suspected cases and a specimen of the pus for bacteriological examination collected from inside the rectum Large doses of penicillin are equally necessary for the treatment of the female as well as the male complications



FIG 14
Papillomatosis of the vulva in a case of chronic gonorrhœa.

VULVAL AND VAGINAL PAPILLOMATOSIS —This is the same condition as occurs (Fig 14) on the prepuce or glans penis in the male (p 60) Good results follow careful painting of the warts with 25 per cent podophyllin resin in mineral oil, but the female patient must always be kept in bed during this treatment Surgical excision is sometimes necessary

The metastatic complications are similar to those that occur in men, but joint affections seem to be less common in women.

Test of Cure is difficult to establish in women The complement fixation test should remain negative over a period of at least six months and a monthly microscopical and cultural examination of both the urethral and the cervical secretion must show no gonococci during this period The specimens should be taken just after the menstrual period.

VULVO-VAGINITIS IN LITTLE GIRLS

This condition, though sometimes caused by other organisms is often the result of gonococcal infection. Epidemics are met with in schools and orphanages where the disease is spread by infected towels and bed linen. In children living at home it can often be traced to one of the parents.

The infection is in most cases limited to the vulva and vagina, the urethra being occasionally and the cervix rarely attacked. It is notoriously intractable and relapses after apparent cure are common, but it does not usually persist after puberty

Vulval irritation is soon followed by a vaginal discharge which, serous at first soon becomes purulent Gonococci are sometimes found in the discharge and after a short time a secondary infection appears. It must not be forgotten that thread worms are sometimes indirectly responsible for non-gonococcal vulvo-vaginitis pyogenic infection being carried to the vulva and vagina by the scratching fingers of the young patient A search for ova should always be made as soon as possible

Treatment consists in rest sitz baths penicillin or sulphonamides. Local treatment is unnecessary and always undesirable as it is distressing to the young patient and may easily initiate a habit of masturbation even in resistant cases it should be confined to simple vaginal irrigation with a very weak antiseptic solution using a soft rubber catheter which may be followed after the first week by the daily insertion of a small glycerin pessary further to encourage drainage The infection frequently spreads to the rectum and no case should be discharged as cured until the rectal flora have been investigated and proved to be free from gonococci

Every case must be rigidly isolated and knickers with no perineal opening should be worn day and night to guard against the possibility of infection being conveyed to the eyes

SYPHILIS

Syphilis is a specific infectious disease due to inoculation with the *Treponema* (or *Spirochaeta*) *pallidum* an organism protozoal in type which was first demonstrated by Schaudin and Hoffman in 1905 It first appeared in Europe in 1493 and is believed to have been imported from the New World by Columbus sailors on their return to Spain.



Fig 15

Two primary chancres, one of the upper lip and the other at the right commissure.

The *T pallidum* is a minute and very fine spirally-shaped organism having six to fifteen spirals each curve measuring $1\ \mu$ *It is actively* motile as can be readily seen in fresh preparations under dark ground illumination. It stains indifferently with aniline dyes Although the treponema has been cultivated outside the body nothing is known of its life history and every attempt at artificial immunisation has failed The higher apes have been inoculated with the organism with similar results to those in human beings.

Transmission of the Disease.—Syphilis *is usually* acquired during sexual intercourse the treponemata in the

infecting party being present either in open genital lesions or as is possibly sometimes the case in the male in the ejaculated semen this may occur even during the incubation period Extra genital infection (Figs 15 16 and 17) sometimes occurs through kissing or using an infected drinking vessel or inoculation may take place through a minute abrasion on the ungloved finger of an examining doctor or nurse The organisms are considered able to penetrate an unbroken mucous membrane and though probably they are unable to gain entry through sound skin it must be remembered that a completely unbroken nail bed is a rarity and that the commonest site of a digital chancre is at the junction of the finger nail and the skin.



Fig. 16
A primary chancre of the dorsum of the hand

Syphilis is a generalised systemic infection and becomes generalised long before the so-called primary lesion appears Though many of the invading organisms are held up in the vicinity of the site of inoculation by the regional lymph glands some pass almost at once into the blood stream and other body fluids It has been shown that if a rabbit s testicle is removed forty-eight hours after inoculation with the organism a week later its blood is infected to such an extent that 0 5 c c of it will transmit the disease



Fig. 1
Digital chancre

In spite of the fact that for clinical purposes the disease is usually divided into three stages the tissue reaction to an invasion of treponemata is always substantially the same The pathological process consists of a local proliferation of mononuclear cells chiefly lymphocytes and plasma cells with a later multiplication of fibroblasts and a consequent formation of fibrous tissue nature s attempt to localise the infection As a result of this reaction many of the organisms are destroyed and in most cases partial or complete healing with fibrosis takes place in much the same manner as it does in tubercular lesions In untreated cases however some treponemata almost invariably survive and when the local tissue immunity has worn off they commence again to multiply and to continue their work of destruction. It appears probable that asymptomatic survival can occur in the testis or vesicles which would explain how an apparently healthy man

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Fig. 17
Digital chancre.

In spite of the fact that for clinical purposes the disease is usually divided into three stages, the tissue reaction to an invasion of treponemata is always substantially the same. The pathological process consists of a local proliferation of mononuclear cells, chiefly lymphocytes and plasma cells, with a later multiplication of fibroblasts and a consequent formation of fibrous tissue: nature's attempt to localise the infection. As a result of this reaction many of the organisms are destroyed and in most cases partial or complete healing with fibrosis takes place, in much the same manner as it does in tubercular lesions. In untreated cases, however, some treponemata almost invariably survive, and when the local tissue immunity has worn off, they commence again to multiply and to continue their work of destruction. It appears probable that asymptomatic survival can occur in the testis or vesicles, which would explain how an apparently healthy man

sometimes years after his original infection can transmit the disease to his wife and to beget syphilitic children

Immunity —Apart from a local tissue immunity it is certain that a considerable degree of general immunity is conferred by the disease, and it has been said that the one certain proof of the cure of syphilis is the acquisition of a fresh infection This appears not to be strictly true and cases of super infection, though very rare undoubtedly do occur

CLINICAL MANIFESTATIONS

The Primary Lesion.—In from anything from two to six weeks after infection there appears at the site of inoculation a small reddish papule which usually proceeds to induration and ulceration. This lesion may be so inconspicuous as altogether to escape notice. Syphilis has been called the great mimic and in no lesion is this more apparent than in the primary one It may simulate an acne pustule a patch of scabies or a mechanical abrasion and patients presenting a chancre of the frænum preputii are often under the impression that their condition is traumatic The absolute necessity of submitting the exudate from every genital ulcer to microscopic examination cannot be too strongly emphasised. In most cases however the primary lesion sooner or later takes on the form of the typical *Hunterian chancre* This consists of a small area of induration in the skin or mucous membrane which soon ulcerates The resulting ulcer is hard and painless to the touch its edge is built up and slopes gradually towards its base which oozes serum but does not bleed readily This serous exudate will be found to contain many treponemata. At the same time the regional lymph glands commence to enlarge The enlargement is discrete and painless and there is no tenderness on palpation. When the infection is acquired in a venereal manner the usual sites for the primary lesion in the male are the mucous surface of the prepuce the glans penis and more rarely the meatus (Fig 18) Occasionally the chancre is situated intra urethrally in which case a slight serous discharge will appear at the meatus and a painless intra urethral induration will be felt The fact that a considerable proportion of cases of stricture of the anterior urethra show a positive Wassermann reaction suggests that this condition is possibly due to the healing with fibrosis of an intra-urethral chancre The primary lesion also sometimes appears on the shaft of the penis (Fig 19) the scrotum the lower abdominal wall and, as the result of sodomy at the anal orifice or even inside the rectum.



FIG 18

A meatal chancre.

In the female the usual sites are the anterior and posterior fourchettes the clitoris the labia minora and majora and far more commonly than was formerly thought the cervix uteri This will explain how so many female syphilitics are able to affirm honestly that they have never noticed anything wrong below Even when the primary cervical lesion is viewed through a speculum it may easily be mistaken for an erosion and it is always advisable when there is any likelihood of syphilitic infection having taken place to palpate the cervix between the two examining fingers for any signs of induration to scarify the lesion and to submit the exudate to microscopic examination

The primary lesion whether genital or extra-genital is usually single but may sometimes be multiple This can be the case where two skin or mucous surfaces are in apposition such as the mucous surface of the prepuce where another lesion may be present on the contiguous portion of the glans penis or in the female on the opposite labium owing to constant friction against the original chancre.



Fig 19

A chancre upon the shaft of the penis.

Provided that infection of the primary sore with secondary organisms is not severe healing will take place within a few weeks even without treatment and if as is often the case there has not been much tissue destruction little if any scarring will remain Noticeable enlargement of the regional lymph glands is usual though by no means invariable and in females where the primary lesion may be cervical, the adenitis will be intra-abdominal and not apparent

The Secondary Manifestations.—Between two and four months after inoculation the generalised infection which has actually existed from the commencement begins to show itself Constitutional disturbances such as headache and slight pyrexia are common but by no means invariable and though one patient may complain of being off colour another will state that he feels fit enough Some slight anæmia is nearly always present and there is usually a slight deficiency of both red cells and hæmoglobin in the blood.

Skin Lesions.—It must again be remembered that syphilis is the great mimic and in the skin lesions of this stage it lives up to its reputation. The earliest secondary lesion takes the form of a macular blush that is usually generalised over the whole body This blush may be so faint that it is not discernible at all on the more exposed parts where it is liable to be masked by sunburn and even elsewhere it may be so faint that it is not visible by yellow artificial light

Sometimes this rash may fade away after a few weeks and there ma
an end to the secondary manifestations Usually however the colo
the macules deepens to reddish brown and a typical raw bacon-colo
rash develops This may be accompanied or succeeded by a pap
eruption The papules take the form of conical or lenticular r
patches varying in size from that of a pin s head to that of a florin
are reddish brown in colour and usually develop at the mouth of a s
gland A few days after their appearance they tend to become th
with small scales which when detached leave a shiny surface ur
neath Treponemata can usually be demonstrated in the serous exu
from the larger papules In moist situations such as around the
or vulva, the papules tend to be larger raw and scaleless owing to
rapid destruction of the already devitalised epithelium Sometim
these places the sodden epithelium becomes heaped up and flat wart
excrescences develop These are known as *condylomata* and trep
mata are always present in their exudate in large numbers Occasio
they may give rise to a good deal of irritation through their beco
infected with secondary organisms and when situated around the
they are not infrequently mistaken by the patient for piles

In the undernourished and anæmic patient from whom treat
has been withheld there may appear a pustular type of papule w
becomes covered by a crusty scab Tissue destruction proceeds u
the crust, which may become raised in characteristic concentric wh
The fully developed lesion resembles a brown limpet shell adheri
the surface of the skin, a condition known as *rupia*.

The appendages of the skin are often affected in this stage o
disease or later and the hair may fall out and the finger and toe
become brittle and fissured. The alopecia of syphilis is distingui
from baldness due to other causes by its characteristic moth-e
appearance in marked contrast with the smooth, clean-cut patch
alopecia areata.

It should be noted that as a general rule the cutaneous r
festations of syphilis do not give rise to any irritation unless
become infected with secondary organisms In patients of uncl
habits this is sometimes the case and the combination of a ma
or papular syphilide with scabies is not uncommon

MALIGNANT SYPHILIS.—This rare condition is characterised
severe ulceration of the secondary cutaneous lesions the pa
rapidly becoming pustular and eventually breaking down to fo
greenish slough The patient is gravely ill, quickly becomes cach
and may die often as the result of orthodox treatment which
too weak to tolerate

MUCOUS MEMBRANES.—The mucous membranes of the mouth
throat are usually affected about the same time or rather earlier
is the skin The first manifestation in the mouth often takes
form of an erythema of the soft palate which stands out in ma
contrast to the paler hard palate Later small shallow ulcers
appear on the tongue buccal mucous membrane fauces and to
These ulcers known as *mucous patches* are in fact papular le
which ulcerate almost immediately owing to their warm moist

In the throat they tend to run together and to become serpiginous and they are often covered with a mucoid exudate From their appearance they are popularly known as *snail track ulcers* Like most other syphilitic lesions this ulceration gives rise to little or no discomfort, and often a very considerable amount of tissue destruction will have taken place before the patient becomes aware of his condition. Mucous patches are also met with on the mucous membrane of the vagina the glans penis and the mucous surface of the prepuce As in the well-developed skin papules treponemata are usually present in large numbers in these lesions.

EYE.—Iritis in varying degrees of severity is not an uncommon manifestation of the disease in the later secondary stage The patient usually complains of ocular pain and photophobia and occasionally there is some dimness of vision. The condition by itself is hard to distinguish from iritis due to other causes but diagnosis is not difficult, *as other signs of secondary syphilis* are almost invariably present.

LYMPH GLANDS —These tend to enlarge slightly all over the body This enlargement is rarely great but it may persist for months or years A convenient position in which it may be felt is in the epitrochlear gland of the elbow but enlargement of this gland is no more pathognomonic of the disease than that of any other A feature of this secondary adenitis is the complete absence of pain and tenderness

BONES —A slight transient periostitis of the long bones is occasionally present and pain is sometimes felt in the shin bones when in bed at night owing to the increased congestion of the part at that time

CENTRAL NERVOUS SYSTEM —Definite nervous symptoms seldom appear at this stage though there is no doubt that infection of the central nervous system takes place in many cases of secondary syphilis This fact has been proved by animal inoculation of the C.S.F taken from these cases Neuralgic pains in the head are fairly common and it is possible that these might be due to a mild inflammatory œdema of the brain tissue.

The Tertiary Manifestations.—There is no hard and fast rule governing the time of appearance of the tertiary manifestations of syphilis Occasionally they follow close in the wake of the secondary lesions and sometimes they are delayed for years or even decades The habitat and mode of existence of the treponemata in the interim are not known

One of the best known and often an early manifestation of tertiary syphilis appears on the skin and is known as the **nodular cutaneous syphilide** The lesion consists of a curved line of intradermal nodules dusky red in colour and usually covered with scales or crusts The curved line tends to meet itself forming a rough circle of a size varying from that of half a crown to a dinner plate Some patchy superficial ulceration is usually present and in parts of the lesion spontaneous healing is seen to be taking place with the formation of scar tissue If untreated the condition extends a well-advanced lesion taking on either a concentric spiral or an S-shaped formation. The lesion is occasionally confused with lupus vulgaris but the differential

diagnosis is comparatively easy as the syphilitic process advances much more rapidly than does the tubercular one

Syphilis in its tertiary stage is liable to attack any part of the body and whichever organ is chosen, the tissue reaction to the specific toxin is essentially the same This consists in an infiltration of mononuclear cells around the arterioles supplying the part attacked a periarteritis and later an obstructive endarteritis of these vessels resulting in a consequent necrosis of the tissues supplied by them An increase of fibroblasts in the area results in a fibrosis which may partially or even totally wall off the infection. The resulting lesion surrounded by its fibrous capsule is known as a gumma. When this is near the surface the skin or mucous membrane is soon involved and ulceration takes place The ulcer is usually fairly typical it is punched out deep and roughly circular its base being occupied by the necrotic material from the centre of the gumma Later this wash leather slough separates healthy granulations appear underneath and healing takes place It will be understood now that the nodular cutaneous syphilide is in fact a succession of small superficial gummata, some of which are breaking down while others are in the healing stage

Discrete subcutaneous gummata may occur anywhere and are commonly seen on the leg, where after ulceration has taken place they must be distinguished from innocent varicose ulcers This is usually not difficult, as the syphilitic ulcer in addition to its characteristic punched-out appearance is in most cases situated in the region of the knee-joint whereas the varicose ulcer is more likely to appear in the vicinity of the internal malleolus Nevertheless in all cases of indolent varicose ulceration a Wassermann reaction should be carried out as the two conditions may exist simultaneously

Visceral gummata are not common but may occur in any of the abdominal or thoracic viscera. Cerebral gummata are also sometimes met with but usually take their origin in the meninges rather than in the actual brain substance

It is outside the scope of this section to describe in detail the syphilitic process in every part of the body Let it be enough to say that any comparatively painless tumour of obscure origin is possibly gummatous and syphilitic infection should always be excluded.

Though discrete gummata are sometimes met with in the bones testes meninges and even in the nervous and cardiovascular systems diffuse syphilitic infiltration is the usual process Here the toxins appear to be "fighting in extended order rather than in the mass formation adopted in the discrete gumma Consequently necrosis is not so much a feature of this form of the disease and a diffuse tissue destruction is quickly followed by fibrosis.

Syphilis of the heart blood vessels and the central nervous system is dealt with at length in all textbooks of medicine As has already been mentioned, the process is usually one of diffuse syphilitic infiltration in cardiovascular syphilis and the vasa vasorum of the great vessels are often the first structures to be attacked These tend to become obliterated and the elastic tissue of the tunica media is

replaced by fibrous tissue which is unable to withstand the intra arterial pressure dilatation takes place and an aneurysm results In syphilitic valvular disease of the heart incompetence is usually caused by shrinkage due to a replacement of the elastic tissue with unyielding fibrous tissue but occasionally small gummata may form in the substance of the valves

General paralysis of the insane and tabes dorsalis are both caused by a diffuse syphilitic infiltration of in the former disease the cerebral cortex and membranes and in the latter condition the nerve fibres of the posterior columns of the cord

Mention must here be made of **Charcot's disease** of the joints (Fig 20) This condition is characterised by a rapid painless swelling of the affected joint which is usually one that has been subjected to over-use Effusion into the joint cavity takes place the articular surfaces of the bones are eroded and considerable grating on movement is felt and later the joint becomes completely disorganised In contrast with other forms of arthritis there is extreme mobility It must be clearly understood that this condition although almost always a sign of syphilis is not due to infection of the joint itself but to disease of the spinal cord, on account of which joint sensation is abolished and the normal reaction to undue stresses and strains is impaired. A similar condition is sometimes met with in cases of syringomyelia which affects the joints of the upper extremity



Fig 20

Bilateral Charcot s joints.

Perforating ulcers on the soles of the feet the so-called trophic manifestations of syphilis of the spinal cord, take the form of ulcerated callosities which refuse to heal and are sometimes the trouble for which the patient first seeks advice they are probably due to unappreciated trauma consequent on anaesthesia of the skin The clinical signs of tabes dorsalis are almost invariably present in the above two conditions

CONGENITAL SYPHILIS

Children born of syphilitic parents are themselves liable to be infected with the disease the infection taking place by the maternal blood stream through the placenta At first the mother often aborts before full term, giving birth to a diseased and often macerated fœtus. With successive pregnancies the fœtal infection may tend to become less severe until at length a full time child is born alive This child may show signs of infection at birth but often appears to be healthy enough, and it is usually not until it is three or four weeks old that its infected condition becomes apparent Frequently this typical sequence is not followed and it is not uncommon for an apparently healthy child to be born between two obviously syphilitic ones.

Loss of weight vomiting and irritability are usually the first signs of the disease and are commonly accompanied by enlargement of

the spleen. In many cases there is also an enlargement of the liver due to a pericellular cirrhosis Often the child's face becomes characteristically putty-coloured and wrinkled and resembles that of a very old man. Before long the skin and mucous lesions of secondary syphilis appear these are liable to be exceptionally severe and treponemata may be found in them in large numbers A macular eruption is usually the first lesion noticed which may be accompanied or followed by a papular one Desquamation of the skin of the fingers and toes is common and is a useful diagnostic feature of the disease On account of the exceptionally warm conditions in which most babies are kept the skin lesions especially the papules tend to become moist and to ulcerate True perianal and vulval condylomata may be present and ulceration of the mucous membranes of the nose mouth and pharynx is common When the nasal mucous membrane is attacked, the constant discharge gives rise to *snuffles* later the infection may spread to the nasal bones which may be partially destroyed. As a result the bridge of the nose falls in producing what is perhaps the best-known stigma of congenital syphilis the *saddle nose*



FIG. 21
Congenital syphilis. *Gumma of frontal bone.*

Cracking of the skin or actual ulceration is common at the angles of the mouth and when healing takes place radiating scars or *rhagades* remain.

If the disease in this stage is left untreated the infant will often die if not of the disease itself from some intercurrent infection It may however survive in which case it will probably carry stigmata to the end of its life and become liable to all the later manifestations of syphilis which occur in the acquired disease Occasionally all signs of infection are delayed until later on in life this is however the exception and it will usually be found on going into the history with the mother that an account of some of the earlier lesions can be elicited It must though, always be remembered that as in acquired syphilis the early lesions may be so slight as altogether to escape observation

The later manifestations of congenital syphilis do not usually occur until after the fifth year but as in the acquired disease they occasionally appear much earlier Though any of the conditions met with in acquired syphilis may be present there do appear to be certain organs in the young for which the treponema has a special predilection, the bones (Fig 21) joints, eyes ears and testes being particularly liable to attack

Bones and Joints.—Osteochondritis of the epiphyses especially of

the lower limbs and periostitis of the bones of the fingers with a resulting fusiform dactylitis are sometimes present in the early stages of the disease these conditions and a periostitis of the lower end of the tibia can sometimes be detected by X ray in young infants or occasionally even before birth Later after the child has commenced to walk and sometimes not until puberty periostitis of the tibia with a resulting *thickening* of the anterior surface of the bone produces the well known curved or **sabre-shaped tibia**, which is sometimes *mistaken for a rachitic* manifestation

The frontal and parietal bones of the skull are often affected quite early in the disease and considerable thickening may take place in the course of resolution This thickening which is usually symmetrical forms the bosses known as **Parrot's nodes**, giving rise to the natiform or hot-cross bun skull Occasionally the bone is replaced by a thin parchment-like membrane then the condition is known as craniotabes **Craniotabes** is comparatively rare and is considered by some authorities to be a manifestation of rickets A similar condition certainly does occur in the absence of syphilitic infection.

Chronic bilateral synovitis of the knee joints is sometimes present in children and young adults. Considerable effusion occurs and there is no pain The enlargements are known as ***Clutton's joints***. Very occasionally the condition is unilateral.

Teeth.—The growth of the milk teeth is often affected adversely but no typical abnormality can be described. The permanent teeth are particularly liable to be modified both in size and shape and are often smaller and more widely spaced than the normal the first permanent molars tending to be ill developed and domed when they are known as **Moon's teeth**. The classical dental stigmata of congenital syphilis are known as **Hutchinson's teeth**. In this condition the upper central permanent incisors are peg-shaped and may be notched. This notch is often absent or may be obliterated by wear in later life but the unmistakable stigma consists in a short peg-shaped tooth considerably broader at its base than at its cutting edge

Eyes.—*The commonest ocular manifestation is interstitial keratitis* This usually appears between the ages of six and fifteen though its onset may occasionally be delayed until as late as the twenty first year The patient first complains of some pain and photophobia and a ground glass opacity of the cornea develops Later leashes of small blood vessels are seen to grow into the opacity and the characteristic salmon patch is produced. Unless vigorous treatment is initiated in the early stages the prognosis is not good, and some interference with vision will often remain. The condition, though commencing in one eye often becomes bilateral

Choroiditis usually combined with *retinitis* is a common manifestation of congenital syphilis in childhood and adolescence Diminution of vision is progressive and retinoscopy reveals the characteristic black and white patches of pigment and exudate

Ears.—Otitis is common in syphilitic infants and is usually brought about by a spread along the Eustachian tube of the syphilitic process or of an accompanying pyogenic infection from nasal or

pharyngeal lesions Nerve deafness owing to meningeal involvement also occasionally occurs between puberty and adolescence the onset is then sudden it is bilateral and complete deafness quickly results

Testes.—Syphilitic infiltration of the testis may occur at any age though it is usually an early manifestation. It is by far the commonest cause of enlargement of the testis in infancy

Cardiovascular Congenital Syphilis is rarely met with in childhood or adolescence and when it occurs in later life it is often difficult to exclude the possibility of an acquired infection.

Central Nervous System.—Juvenile tabes dorsalis and congenital general paralysis are occasionally met with, and present much the same signs and symptoms as they do in the adult The conditions are rarely noticed before puberty but the Wassermann reaction of the C.S.F has often been found to be positive in quite young children.

Third Generation Syphilis.—It was formerly dogmatically held that syphilis could not be transmitted to the third generation, but recent observations seem to have proved that in some cases this does take place They must however be comparatively rare and the vast majority of congenital syphilitics do not appear to beget syphilitic children In the investigation of a suspected case the difficulty of proving the absence of an acquired infection in the second generation will be appreciated.

THE DIAGNOSIS OF SYPHILIS

As has already been pointed out the early manifestations of syphilis may be so slight as to escape the patient's notice An intra-urethral or sub-preputial chancre in the male may easily be overlooked, and in the female a cervical chancre will rarely give rise to symptoms The secondary macular eruption may be so faint as to escape detection and unless the patient is examined in strong daylight or by the light of a daylight lamp may be missed by the examining surgeon. In all cases where there is any doubt the diagnosis can always be confirmed by microscopic and serological tests and so efficient are these that no diagnosis of syphilis should ever be made without the employment of one or both of them.

The Primary Lesion.—Unless strong antiseptics have already been applied by the patient, treponemata may always be readily found in the lesion. The ulcer should be rubbed with dry gauze or gently scarified until slight hæmorrhage takes place as soon as clotting has commenced a little of the serum is transferred to a slide a cover glass is applied, and the specimen is examined microscopically by the method of dark ground illumination, a special condenser and an exceptionally high powered lamp being used the treponemata can then be observed in the living state In cases where the lesion is not readily accessible one of the enlarged regional lymph glands may be punctured with a hypodermic needle and some of the gland fluid drawn up into a syringe the fluid is then examined and the organisms can usually be demonstrated therein. This method of diagnosis should always be tried before subjecting a phimotic patient to the mutilating

operation of a dorsal slit up to expose a hidden chancre as local sub-preputial medication can always be applied with a syringe as soon as a diagnosis has been made

In the case of a suspected cervical lesion the cervix should first be well cleaned with a dry swab and if bleeding does not readily take place it should be gently scarified When clotting occurs the serum can be conveyed to a slide by means of a sterile platinum loop

Treponemata are invariably present in condylomata mucous patches and the larger skin papules and search should be made for them in these lesions if the primary sore has healed before the patient presents himself for examination In secondarily infected genital lesions care must be taken not to mistake *Spirochæta refringens* for the specific organism this is a short coarse spirochæte which unlike the delicate slow moving treponema travels with great rapidity across the microscopic field Non-specific spirochætes resembling the treponema are often present in mouth lesions which sometimes makes microscopic diagnosis extremely difficult

The Wassermann Reaction.—This test which was introduced in 1906 depends upon the presence or absence of hæmolytic power in the serum under fixed known conditions The test does not become positive until six to eight weeks have elapsed after the original infection consequently the early diagnosis of recently acquired syphilis depends upon the finding of the organism in the primary lesions before there has been time for the Wassermann to become positive

Other serological tests for syphilis are the flocculation tests of Kahn Meinicke Price and others. These depend on the principle that when a cholesterinised extract of heart muscle is added to a warmed syphilitic serum flocculation occurs in the mixture they are useful as confirmatory evidence especially in cases where the Wassermann gives a doubtful result but up to the present in this country none of them has replaced the last named test in general use

For these tests the blood should be collected from a vein in the bend of the elbow or in an infant using a Wright s capsule by puncture of the skin covering the heel, congestion of the part having been effected by massaging or bandaging the limb in a downward direction Great care should be taken that the collecting needle and syringe are free from spirit otherwise some hæmolysis may take place before the test is carried out and the result seriously vitiated.

In this country where tropical diseases akin to syphilis do not prevail a strongly positive Wassermann reaction or Kahn test can usually be regarded as evidence of syphilitic infection though false positive tests are sometimes met with in patients who have recently suffered from infectious mononucleosis (glandular fever) or malaria On the other hand a negative reaction may be obtained in a syphilitic and will mean one of three things namely —

1 That enough time has not elapsed since infection for the tests to become positive
2 That though infection is still present treatment has caused the reaction to become temporarily negative

3 Rarely that though the patient is infected and has not been treated, his blood for some obscure reason has not developed the reagin on the presence of which the test depends

In all cases where a positive blood test supports a diagnosis of late or latent syphilis, disease of the cardiovascular and nervous systems must be excluded or confirmed by clinical and radiological examination of the heart and great vessels and by a full examination of the cerebrospinal fluid. Not until this has been done will it be possible to plan optimum treatment for the particular case

Prophylaxis.—*Treponema pallidum* is an extremely delicate organism and provided that thorough disinfection of the genitalia is carried out within two hours of a venereal exposure the risk of infection will be diminished. After this time the organism has almost certainly "dug itself in" beyond the reach of the most powerful antiseptics and prophylactic measures taken then, far from destroying the infection, may have the effect of delaying the appearance of the primary lesion, so that the disease will become well-established before it can be diagnosed and treatment commenced

IMMEDIATE PROPHYLACTIC MEASURES in the male should include —

1 Urination
2 Thorough washing of the parts with soap and water
3 Swabbing of the genitalia especially the mucous surfaces with 1 2000 perchloride of mercury and
4 Inunction of the parts with 33 per cent calomel ointment some of which should be squeezed out of a collapsible tube into the urinary meatus and gently massaged into the urethra.

A patient who has run a known venereal risk should be kept under observation for three months blood tests being carried out during and at the end of that period.

The practice of giving an injection of penicillin or of one of the salvarsan substitutes as a prophylactic measure after a venereal risk cannot be too strongly condemned If infection has taken place it may have the effect of delaying the appearance of signs for a considerable time and it can never be relied upon to destroy all the infecting organisms

THE TREATMENT OF SYPHILIS

Certain guiding principles should be followed by anyone who undertakes the treatment of syphilis These are that —

1 The earlier treatment is commenced the better will be the result.
2 Treatment once commenced, should be adequate Half measures are dangerous and recurrences are common in insufficiently treated cases.
3 Post treatment observation should be prolonged until one is satisfied by the strictest tests that the infection has been eradicated

4 The nature and implications of the treatment should be carefully explained to the patient the danger of premature default either from treatment or surveillance should be pointed out to him and he should be reassured of his safety so long as he carries out orders

The drugs used in the treatment of syphilis are penicillin the arsenical compounds (which include arsphenamine neoarsphenamine sulpharsphenamine and arsenoxide) oily and watery suspensions of bismuth and its salts and potassium iodide The last named drug unlike the others has no treponemocidal action but is said to aid the autolysis of necrotic substances and of newly formed fibrous tissue thus making the organisms more accessible to the other drugs

Penicillin.—Judging from its dramatic effects on both the early and late cutaneous manifestations of syphilis and the speed with which spirochaetes disappear from primary chancres penicillin would appear to be the most powerful spirochaeticidal substance known The experience of the last six years has reinforced this opinion and many hundreds of thousands of patients seem to have been cured with penicillin alone It appears to be unnecessary to admit early syphilitics to hospital for round the clock penicillin treatment and many clinics are now treating their early cases with from eight to ten daily injections of 600 000 units of procaine penicillin combined with one course of ten weekly injections of an arsenical drug and bismuth the results of this treatment are up to the present most encouraging It is the writer s opinion that the addition of arsenicals is probably unnecessary and during the last two years excellent results have been obtained at St Mary s Hospital with penicillin and bismuth alone

In cardiovascular syphilis it is safer always to commence treatment with at least ten injections of bismuth (0 2 grm.) alone with concurrent iodides by the mouth after this penicillin or arsenical treatment may be cautiously started.

The intramuscular preparations of mercury have been generally superseded by those of bismuth, the latter having proved itself to be equally efficient and less toxic in its action.

In syphilis of the central nervous system strenuous treatment is particularly essential and the progress of the disease can often be halted by one or more courses of penicillin

Penicillin either alone or combined with malarial inoculation is particularly effective in the treatment of dementia paralytica and that the death rate from this disease has declined sharply during the last three years can probably be attributed to its increasing use

In early congenital syphilis the procedure is on the same lines with correspondingly reduced dosages of penicillin and bismuth as in the acquired disease the blood tests becoming negative in due course Later lesions usually respond well but the tests are apt to remain positive as in the later stages of the acquired disease

Though it is difficult at this stage to rule to what extent penicillin can replace the time-honoured drugs in the treatment of late acquired or congenital syphilis it is probably correct to say that in every case

Marriage.—No patient who has been treated for early syphilis should be permitted to marry until blood and cerebrospinal fluid have remained negative for at least two years after the cessation of treatment Women should always be treated throughout their pregnancies if signs of syphilis are present in their consorts or if they have previously received anti-syphilitic treatment even if their blood tests are negative Treated late syphilitics are most unlikely to infect their spouses even though their blood tests remain positive but where the patient is a woman permission to marry should always be conditional on her agreeing to treatment with a standard course of penicillin and bismuth during any subsequent pregnancy to insure against the remote possibility of her child becoming infected.

CHANCROID

Chancroid, Soft Sore or Ulcus Molle.—These names are sometimes loosely applied to any venereal sores which prove to be non-syphilitic but it is more correct to limit them to the fairly typical infectious venereal condition, which follows contagion with Ducrey's streptobacillus. This organism is a short Gram negative bacillus which like the streptococcus tends to adopt a chain formation. On account of an invariable accompanying secondary infection it is not easily recognised in stained specimens and is extremely difficult to cultivate

In anything from one to five days after infection a red papule, which quickly ulcerates appears at the site of inoculation. These ulcers which are frequently multiple are characteristically painful, shallow ragged-edged and unlike the primary syphilitic lesions have a tendency to spread In debilitated patients and those of unclean habits the ulcers occasionally become phagedenic often with considerable loss of tissue The ulcers are accompanied or followed after healing has taken place by a painful and tender inguinal adenitis which may be unilateral or bilateral. Suppuration generally occurs and the overlying skin becomes red and inflamed the resulting swellings being known as buboes

Diagnosis.—Scrapings taken from the edge of the ulcer and stained by Gram's method will occasionally reveal the presence of Ducrey's bacillus but more often than not the organisms cannot be found. In all cases repeated search should be made for the *T pallidum* and to exclude syphilis the Wassermann reaction must remain negative for twelve weeks after the appearance of the ulcer

Treatment.—The patient should be put to bed and the ulcers cleaned with frequent applications of peroxide of hydrogen, followed by local application of sulphanilamide powder In phimotic patients a syringe should be used and the preputial sac constantly cleansed. If the pain is severe powdered aspirin is an excellent local anæsthetic

Most cases of chancroid react well to sulphathiazole 4 to 5 grm. of which are given daily in divided doses for six to seven days This treatment is also effective against secondary streptococcal infection and will minimise the chance of phagedenic ulceration occurring

Good results also follow the intravenous injection of Dmelcos a vaccine prepared in France from Ducrey s bacillus the initial dose being 1 c c (225 million organisms) The injection which is followed by some pyrexia and malaise is repeated at three-day intervals the dose being increased by 1 c c daily up to a maximum of 3 c c On this treatment the ulcers frequently heal within a fortnight and the adenitis may resolve without any further treatment being necessary If Dmelcos is unobtainable similar results will sometimes follow the intravenous injection of T.A B vaccine in doses of 25 to 75 million organisms Chancroid is a gangrenous process and where phimosis is present the prepuce should be slit up without delay the ulcer inspected and any sloughs cut away

As soon as the bubo suppurates it should be aspirated a wide bored needle to which is attached a 20 c c Record syringe being passed through sound skin into the centre of the gland If the cavity refills the procedure is repeated daily for three days After this if the bubo has not subsided it should be freely incised Penicillin is completely ineffective in this condition and its use even in streptococcal genital ulceration is not generally advisable except when sulphonamides and local treatment have failed, owing to the danger of an underlying syphilitic infection being masked

It cannot be too strongly emphasised that in this country chancroid is a relatively uncommon disease and that in all cases the possibility of a syphilitic infection should be rigorously excluded.

LYMPHOGRANULOMA VENEREUM

(*Syn* Lymphogranuloma Inguinale)

This condition—the so-called climatic bubo—is not an uncommon disease in the tropics but is extremely rare in this country though from time to time a few authentic examples are recorded The causative organism or virus has not yet been isolated and the incubation time is not known

The primary lesion is not typical though there is generally a history of a small genital abrasion which rapidly healed, and the patient usually first seeks advice on account of a comparatively painless enlargement of the inguinal glands In women the condition sometimes remains undetected for a considerable time as the adenitis occurs in the intra-abdominal glands, presumably following a primary lesion on the cervix Stricture of the rectum from a periadenitis with adhesions may give rise to the first noticeable symptoms

The adenitis may remain stationary for weeks or even months but as a rule suppuration eventually takes place

Diagnosis.—The aspirated gland fluid or pus does not contain spirochaetes or other organisms and the blood tests for syphilis are negative and remain persistently so Diagnosis is made by Frei s test An injection of antigen (0 1 c c) prepared from the causative

virus grown artificially on allantoic membrane is made intradermally into the forearm a control injection of uninfected egg protein being made into the opposite forearm. A positive reaction which appears within forty-eight hours is indicated by the appearance of a raised inflammatory area at the site of inoculation which persists for several days.

Treatment.—The majority of early cases respond well to sulphon amides in a similar dosage as for chancroid Good results can also be obtained with aureomycin but this drug has the disadvantage of masking a possible concurrent syphilitic infection

Granuloma Inguinale (*Syn* Granuloma Venereum—ulcerating granuloma of the pudenda) —This tropical venereal disease as the name implies is a granulomatous process of the external genitalia or the surround ing tissues. The causative organism is the Donovan body probably a protozoon which it has not been possible to culture *in vitro* After a variable incubation period of from one to twelve weeks a localised area of induration develops. This gradually increases in size softens and ultimately breaks down The condition shows little tendency to heal and slowly spreads particularly in the moist areas between the scrotum and the thigh and up into the abdominal wall causing gross tissue destruction. The resulting ulcerative area is velvety and bright red, the edges are rolled and the exuberant granulation tissue bleeds easily Donovan bodies are seen in tissue section stained with hæma toxylin and eosin The disease responds well to streptomycin excellent results being obtain d following injections of 1 grm four times a day for five days

G L. M. McElligott

CHAPTER VI

TUMOURS AND CYSTS

TUMOURS

AS a result of intense and world wide study the nature of true tumour formation is well understood but its real causative factor (or factors) remains unknown In the present state of our knowledge therefore no exact definition can be formulated The best available is A mass of cells tissues or organs resembling those normally present in the body but arranged atypically which grow at the expense and independently of the organism without subserving any useful purpose therein. The term tumour is unfortunately used indiscriminately to include any abnormal swelling but its use should be restricted solely to true neoplasms and should not be applied to such processes as simple hypertrophy and inflammatory reactions

ETIOLOGY

Although the essential causative factor is unknown several facts of etiological importance are recognised

1. **Age** incidence varies with different types of tumour but generally speaking the carcinoma ages are between 35 and 65 years the peak being reached in men at 55 and in women at 50 Sarcoma is not so commonly found in young people as was once thought and its age incidence closely resembles that of carcinoma A few rare congenital tumours certain sarcomata and many teratomata are seen in childhood and adolescence

2 **Sex.**—Malignant disease occurs more frequently in women than in men in the ratio of 3 2 This difference is largely accounted for by the high incidence in the breast and generative organs of the female On the other hand, cancer of the tongue buccal cavity pharynx and larynx is rare in women

3 **Heredity**—There is no real evidence to show that heredity has any important etiological significance

4 **Locality**—No convincing statistical evidence is available to support the theory of cancer houses and cancer districts nor is there the slightest evidence that cancer is either infectious or contagious

5 **Injury and Irritation.**—The history of a blow is quite frequently found in carcinoma of the breast and in teratoma of the testis and it is possible that the injury may have provided the stimulus to new growth formation

The clinical and experimental evidence in favour of chronic irritation forms a more formidable contribution. It is established beyond doubt that long-standing chronic irritation does produce malignant disease A few examples must suffice viz. the association of

gall-stones and carcinoma of the gall bladder scrotal cancer in sweeps surface growths in paraffin workers the kangri cancer of the abdominal wall in the natives of Kashmir who carry their charcoal fires beneath their clothes the cancer arising in old lupus scars and finally the experimental production of cancer by the Imperial Cancer Research workers with tar painting in animals

THEORIES OF TUMOUR FORMATION

These cannot be adequately dealt with in a textbook of surgery and the reader is referred to works on pathology for a full description The *extrinsic* theory postulates the existence of a parasite or virus introduced from without which is responsible for the tumour formation but no evidence has ever been brought forward to support this view There are several *intrinsic* theories, amongst them being (1) the alteration of tissue tension by which the balance normally held between the epithelium and connective tissue of an organ is upset (2) Cohnheim s theory of the persistence of embryonic cells in the body after birth (3) theories of alterations and abnormalities of growth and (4) the theory of heterotype mitosis which implies that tumour cells are similar to reproductive cells in having half as many nuclear chromosomes as normal somatic cells Lastly Gye s work seems to combine the extrinsic and intrinsic theories for he has described the existence of an ultra microscopic virus which can be isolated from certain animal growths. This virus cannot however produce any effect unless combined with his specific factor a virus free extract of the tumour cells *When this combination of virus and specific factor is injected* into an animal of the same species a malignant new growth develops This work is not necessarily applicable to the human, and further corroboration is needed before it can be accepted At the present time it must be acknowledged that the question of the origin of cancer has defied solution.

STRUCTURE AND GROWTH OF TUMOURS

All tumours consist of two parts the supporting connective tissue framework or stroma and the tumour cells proper The relationship between the two varies considerably in different growths for whereas in epithelial growths they are easily distinguishable in the connective tissue growths the stroma may be indefinable The cells in innocent growths are typical i.e they resemble their parent cells so closely that their origin is never in doubt but in malignant tumours the cells are often atypical," i.e. they differ from their parent cells and tend to revert to embryonic or immature forms so that it may be difficult to identify the tissues from which they have arisen.

The stroma is derived from the connective tissue of the organ from which the tumour is growing and is the framework that carries the blood vessels and lymphatics which supply the tumour cells with nourishment and remove their products of metabolism The stroma reaction may be so excessive as to strangle the tumour cells and bring

about a natural cure but on the other hand the tumour may outgrow its stroma so that its central parts may be starved of blood and undergo degenerative changes.

INNOCENCY AND MALIGNANCY

All tumours are divided into two main groups the innocent and the malignant and in the great majority of cases it is possible to say with confidence to which group a tumour belongs although it is sometimes extremely difficult even for a pathologist to place a tumour in its proper class with certainty

An Innocent or Benign Tumour increases in size by uniform growth throughout the whole mass i e., by expansion the surrounding tissues being compressed or pushed aside It is enveloped in a true capsule of fibrous tissue derived from the tissues of the host by compression and tissue reaction It is often multiple does not recur after removal and does not produce metastases.

A Malignant Tumour is almost invariably fatal unless removed or destroyed. It is not however this ultimate result which forms the criterion of malignancy but rather certain definite properties which these tumours possess These accepted signs are (1) Constant and steady increase in size with varying rapidity in different cases (2) a tendency for the cells to become embryonic in type (3) the tumour extends its borders by an infiltration of the surrounding tissues which are gradually destroyed or enveloped (4) involvement of the skin or mucous membrane leads to ulceration or fungation (5) metastases are formed in the lymph glands and viscera (6) the growth recurs locally after removal unless all its ramifications have been excised and (7) cachexia and anæmia occur as late manifestations

METHODS OF SPREAD OF MALIGNANT TUMOURS

A malignant growth spreads locally by infiltration and generally throughout the body by dissemination

Local Infiltration is the process by which the growth extends its borders and spreads into the surrounding tissues It is the earliest sign of malignancy because when overactive cells penetrate their limiting or basement membranes and enter the tissues beneath, then infiltration has begun and a malignant process has been established Active growth in malignant tumours occurs chiefly at the periphery and the surrounding tissues are invaded by columns or groups of cells which work their way between muscle bundles and fat lobules into tissue spaces and into lymphatic and blood vessels These tissues are not displaced and pushed aside but are enveloped and destroyed by the advancing tumour cells (Fig 22)

Dissemination is the process by which the tumour spreads beyond its site of origin and gives rise to secondary deposits or *metastases* in other tissues and other organs of the body It is the general rule that these secondary growths correspond in appearance and behaviour to their parent tumours but this is not always so The metastasis may be more or less actively growing than the primary growth it may completely dominate the clinical picture though as a rule the

primary is larger than any of its secondaries a primary malignant melanoma may contain little pigment whereas its secondary deposits may be jet black. Such examples may be multiplied but usually the metastases breed true to type Another feature of importance is the site in which the secondary deposits develop All forms of carcinoma affect the lymph glands which drain the area while growths in the area of the portal circulation tend to metastasise in the liver Certain tissues appear to offer favourable conditions for the development of secondary deposits of given tumours and they are therefore termed tissues of predilection The metastases for example of carcinomata of the breast thyroid prostate and kidney show a

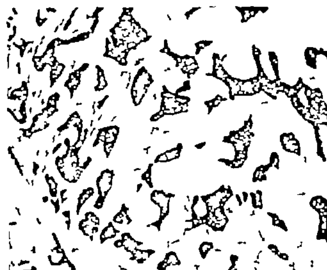


Fig 22

Section from the growing margin of a carcinoma simplex of the breast Groups of carcinoma cells are seen infiltrating fatty tissue. (*Keith*)

particular tendency to settle in bone whereas the brain pancreas, intestine spleen and skeletal muscle are rarely the seat of secondary growths Another important fact is the time at which secondary growths appear after the recognition of the primary tumour Different growths in similar organs vary greatly in this respect Some tumours disseminate so rapidly that within a few weeks the case is hopelessly inoperable while in others the patients remain free of any demonstrable secondary deposit for many months

Dissemination may occur in one of three ways

1 Permeation.
2 Embolism.
3 Transplantation.

PERMEATION is the gradual extension of a tumour by active growth of cells in and along lymphatic vessels (Fig 23) It is seen well beyond the periphery of the growth and constitutes the most advanced limit of extension of the tumour The lymph vessel is occupied and distended

by cancer cells, its walls become stretched and later will burst. The presence of these cells within the lymphatic calls forth a perilymphatic

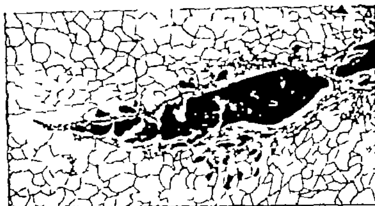


FIG. 23

A section showing the permeation of a lymphatic vessel by carcinoma cells from a primary focus in the breast. (*Keith.*)

reaction, in which round cells and fibroblasts are laid down until eventually the cancer cells are strangled and killed, the lymphatic vessel

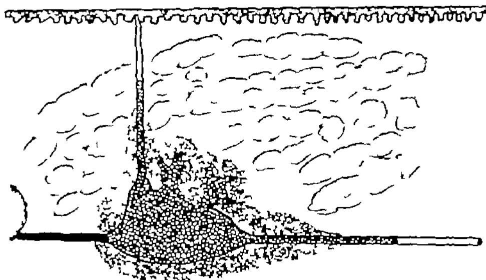


FIG. 24

Diagram illustrating permeation of a lymphatic vessel from a carcinoma of the breast (seen at left lower edge in green). A solid column of carcinoma cells is seen growing inside an intact lymph vessel to the right. Farther back is seen a perilymphatic round-celled infiltration, and behind this cancer cells have broken through the basement membrane and are infiltrating in fat and breast tissue. From this area also is seen a lymph capillary from the has in process of permeation. Near the growth the black line represents the final occlusion of the damaged lymphatic by fibrosis.

being converted into a fibrous cord. At the distal end, however, the column of cells is still advancing by active cell division and nodules of growth may appear at some distance from the primary tumour having no apparent connection with it (Fig. 24). Sampson Handley has

shown that permeation occurs in vessels of medium size in which the force of the current is insufficient to sweep the cells away as emboli. He has also pointed out that although the processes of infiltration and permeation have certain superficial resemblances they are separate and distinct in several important particulars

Infiltration occurs in tissue interspaces is the earliest sign of malignancy is best seen at the macroscopic growing edge and is a slow process Permeation is limited to lymphatic vessels is of later occurrence is best seen at the microscopic growing edge often several inches from the apparent margin, and is a comparatively rapid process These two methods of spread are interchangeable for permeating cancer cells may burst their way through the walls of the lymphatic vessels and infiltrate the surrounding tissues while an infiltrating group of cells may erode and enter a lymphatic vessel and begin to permeate it

EMBOLISM may occur in either the venous or the lymphatic circulations, small groups of malignant cells gaining admission to the lumen of these vessels by direct invasion of their walls Such cells are then carried along in the circulation until they are arrested in the first capillary system they encounter *e.g* the lungs liver or lymphatic glands In sarcoma embolism is the most important method of dissemination but in carcinoma it appears to occur late in the disease and although important it is variable in occurrence and in many cases is overshadowed by infiltration and permeation

TRANSPLANTATION of tumour cells from a parent growth to a new situation is an uncommon phenomenon in human pathology

Transplantation by contact has occurred from lip to lip from cervix uteri to vaginal wall and in hollow viscera from one wall to another as in cases of papillomata of the bladder

Transcœlomic implantation refers to serous membranes *e g* the pleura and the peritoneum If a nodule of growth appears on the parietal layer of a serous membrane small groups of cells may be detached from its surface by the movement of the viscera, and may be grafted on to the membrane either in the immediate vicinity or at a distance A notable example of this process is the Krukenberg tumour of the ovary usually bilateral which is secondary to a gastric carcinoma

Transplantation by inoculation may occur in the course of operation for the removal of malignant growths tumour cells being spilt in the exposed tissues an early local recurrence resulting

CLASSIFICATION OF TUMOURS

There are so many varieties of tumour and so many transitional forms that a classification of real value is a matter of great difficulty and for purposes of description the following arrangement has many advantages —

A Innocent Connective Tissue Tumours

Fibroma	Chondroma	Myoma
Lipoma	Osteoma	Neuroma
Myxoma	Odontoma	Glioma
Chordoma	Osteoclastoma	

B Malignant Connective Tissue Tumours
Sarcoma

C Innocent Epithelial Tumours
Adenoma and Papilloma

D Malignant Epithelial Tumours
Carcinoma including Hypernephroma

E Melanoma

F Endothelioma including { Hæmangioma, Lymphangioma, Meningioma }

G Teratoma.



THE INNOCENT CONNECTIVE TISSUE TUMOURS

FIBROMA

A fibroma is derived from fibrous connective tissue which is a component of most parts of the body but in spite of its wide distribution a true fibroma is of rare occurrence It is an innocent tumour which compresses the surrounding tissues to form a capsule and when near the surface of the body or of the alimentary canal it tends to project as a pedunculated growth It is described as being of two varieties hard and soft

The **hard fibroma** (Fig 25) is a firm lobulated tumour which on section is seen to be composed of fibrous tissue having a white glistening whorled appearance It consists of fibrous tissue and fibroblasts arranged in interlacing bundles so that lobules are formed, which are separated by a delicate stroma of connective tissue carrying fine capillary vessels These tumours tend to undergo degenerative changes of a mucoid or calcareous type

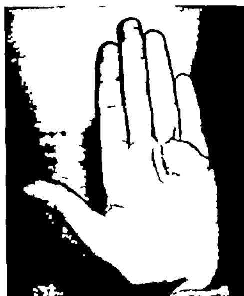


FIG 25
A hard fibroma of the palm of the hand.

The **soft fibroma** is more cellular and contains less adult fibrous tissue Its tissue spaces are wider it is more vascular and there may be œdematous fluid in it It is a much softer tumour and may be mistaken for a lipoma or a sarcoma

The diagnosis of a true fibroma should never be made until a

nature of a diffuse hypertrophy rather than a true new growth. They may be multiple and symmetrical and are often met with in men who have lived sedentary lives and drunk to excess.


FIG. 27
A large subfascial lipoma arising from the region of the gluteus maximus.

ADIPOSIS DOLOROSA or Dercum's disease affects women at the menopause and results in deposition of masses of fat in various parts of the body. The condition is a manifestation of hypothyroidism and is associated with severe neuralgic pains.

MYXOMA

A myxoma is a tumour composed of embryonic connective tissue comparable to that found in the umbilical cord, and is one of the rarest of all new growths. Mucoid degeneration occurs in many tumours and a myxomatous appearance results; again, oedema in a fibroma or in an inflammatory polypus may lead to mistakes in diagnosis.

A true myxoma consists of embryonic connective tissue cells with fine long radiating processes separated widely from each other. The spaces in this meshwork are filled with mucin. Clinically they appear as firm rounded and elastic tumours which contain a glairy fluid. It is probable that a *ganglion* may be of this nature.

CHORDOMA

A chordoma arises from the remnants of the notochord at the base of the skull or in the sacro-coccygeal area. These tumours are very rare and of doubtful innocency. Microscopically they resemble chondromata but are alveolar in arrangement and more cellular.

CHONDROMA

A chondroma is an innocent tumour composed of hyaline or fibro-cartilage being of slow growth and having a definite capsule. When of large size it becomes lobulated. On section it is blue-grey in colour, semi-translucent and homogeneous. These tumours are liable to several types of degenerative processes such as calcification, ossification, myxomatous and sarcomatous changes. Microscopically their structure differs from normal hyaline cartilage only in the variation in size, number and arrangement of the cells.

Chondromata are quite common and arise in connection with (1) long bones, the short bones of the hand and foot, the pelvis and the ribs; (2) normally existing cartilage; and (3) in certain organs which normally contain no cartilage, *e.g.* testis, ovary, kidney, etc. These last are examples of teratomata and not pure chondromata. Clinically these tumours are of three types.

Ecchondromata may be either single or multiple They arise from the shafts of long bones close to the epiphyseal line and it is probable that they grow from islands of epiphyseal cartilage which have been separated and displaced from their parent cartilage by such diseases as rickets. This type invariably becomes converted into true bone and is then known as a cancellous osteoma Another type of ecchondroma arises from the shafts of long bones forming large lobulated tumours which may undergo several changes such as calcification ossification and sarcomatous degeneration They give symptoms only by pressure on surrounding structures, *e.g* pain from nerve involvement or mechanical interference with movement of a limb

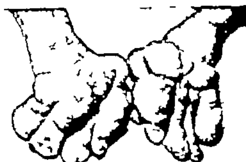


Fig 28
Multiple enchondromata of the hands in an elderly woman.

Enchondromata are frequently multiple and occur in the meta carpals and phalanges of the hand (Fig 28) and occasionally in the feet They arise in isolated cartilaginous rests of the original cartilage from which the bone develops and are seen in young adults They produce a fusiform enlargement of the shaft of the affected bone and if they grow to a large size the shell of bone will give way and the tumour grows into the surrounding structures Enchondromata never form bone but become calcified and occasionally sarcomatous in which case a spontaneous fracture may be the earliest sign. Diagnosis is made by X rays and treatment consists in local excision of the tumour followed if necessary by bone-grafting

Cystic Chondromata occur in the bones of the pelvis and the ribs forming lobulated tumours which neither ossify nor calcify but undergo myxomatous degeneration with the formation of cystic spaces and later tend to become sarcomatous especially after an incomplete removal The treatment of these tumours in the ribs is a resection of that part of the rib which carries the growth those growing in the pelvis are frequently not amenable to operative removal and if such attempts are made usually recur as rapidly growing chondro-sarcomata. X ray or radium therapy offers the best chance of success

OSTEOMA

Osteomata are benign tumours of bone and are of two distinct types cancellous and ivory

Cancellous Osteomata are either single or multiple and are the result of ossification of ecchondromata They arise in displaced islets of epiphyseal cartilage and may be associated with rickets The multiple type often show a familial tendency several members of the same family being affected. They appear about puberty and continue to grow till the parent cartilage disappears. They consist of true

cancellous bone with a covering of compact bone and have a cap of hyaline cartilage An adventitious bursa frequently develops over the surface of the cartilage

Clinically these tumours appear as hard outgrowths from the bone near an epiphyseal line usually having a narrow pedicle the soft tissues being freely movable over them. The only symptoms are pain from pressure on nerve trunks and some form of interference with the movement of the neighbouring joint due to the sudden slipping of a tendon across the osteoma accompanied by a slightly sickening sensation.

Treatment consists in removal if any symptom is present. The pedicle is chiselled through flush with the surface of the shaft of the bone great care being taken to remove the cartilage entirely lest a recurrence should occur

Ivory Osteomata arise in the membrane bones of the skull, forming a rounded sessile mass which grows either outwards beneath the scalp or inwards towards the dura The external ones are accompanied by considerable pain but the internal are symptomless unless they reach a large size and press upon the subjacent area of brain. These tumours may affect the orbit and displace the eyeball, or fill up one of the nasal air sinuses

Treatment is not called for unless there are definite symptoms in which case the tumour should be removed with a margin of normal bone around it.

Certain *exostoses* which are not truly neoplastic, may usefully be mentioned here Bony outgrowths may occur in certain situations where the bone is subjected to constant pressure or tension for example in the condition known as rider's bone ossification spreads from the adductor tubercle into the adductor magnus tendon and a traumatic exostosis results The well known os calcis spur" with ossification extending into the long plantar ligament is another example The *subungual exostosis* usually occurs in the big toe from the terminal phalanx of which a bony spur projects beneath the nail. The latter becomes broken and distorted and finally the exostosis reaches the surface and is covered with a mass of exuberant granulations. It is inflammatory in origin and gives rise to considerable pain The treatment consists in removal of the exostosis the nail and all diseased tissue

ODONTOMA

Odontomata are tumours arising in connection with the teeth, which are developed from a downgrowth of epithelium into the anlage of the jaw This downgrowth forms the enamel organ and is surrounded by a condensation of mesoblast from which is developed the dental sac dentine and cement substance The odontomata arise from errors of development of the [illegible] structures and may therefore be of mixed origin. Only [illegible] are important in human pathology

The Epithelial Odontome, F

Adamantinoma (Fig 29) arises in the remains of the epithelial down-growth from which the enamel organ is produced Being of epithelial origin its description may appear out of place among the connective tissue tumours but it occurs in the jaws as a primary growth and it is customary to include it in this category It affects the lower jaw of young adults in which it forms a dense hard tumour which grows to considerable size expanding and eroding the bone Macroscopically it appears as a fibrous tumour containing cysts of varying size and number Microscopically it consists of branching masses of epithelial cells lying in a dense fibrous stroma the outer cells being columnar the inner ones flattened, and numerous cysts containing mucoid fluid are present (Fig 30)



Fig. 29

An epithelial odontome or fibrocystic disease of the lower jaw

Treatment is local excision of the growth in its early stages but when it is large the affected part of the jaw must be removed and a graft inserted.



Fig 30

Section showing the structure of an epithelial odontome. The columns of epithelial cells and the formation of cystic spaces are well seen (1). (*Keith.*)

The Follicular Odontome or Dentigerous Cyst results from the imperfect development of a secondary tooth which remains unerupted. Certain changes occur in the dental follicle which lead to the formation of a cyst. The tooth is usually imperfectly formed and is attached to the cyst wall in an abnormal position, being either inverted or horizontal The cyst occurs in either sex and in either jaw but more commonly in the maxilla which it expands It is readily diagnosed, because there is a tooth missing in the dental arcade in the region of the swelling (unless the milk tooth persists) there is no history of an extraction and an X ray shows the retained tooth

Treatment consists in resection of the cyst intact with the contained tooth.

The Composite Odontome is rare and consists of a hard mass in which enamel dentine and cement are intermingled without any attempt at the formation of a tooth.

The Cementome is a tumour consisting of cement substance only which arises from ossification in the capsule around the developing tooth germ.

The Radicular Odontome consists of cement and dentine and develops at the root of a tooth. It gives rise to great pain

The Compound Follicular Odontome is a follicular odontome involving more than one tooth germ, and many ill formed denticles are present in the cyst

The Fibrous Odontome does not occur in human beings It is due to fibrosis around the dental sac.

OSTEOCLASTOMA

These tumours have been known in the past as myelomata or myeloid sarcomata, and considerable difference of opinion has existed as to their nature The multinucleated giant cells in which these tumours abound have been regarded as derivatives of the myeloplaxes of the red marrow and the tumours were thought to be growths of the marrow and not of the bone itself. It is now accepted however that they are derived from the specialised bone reticulum from which the osteoclasts are developed and are therefore truly primary bone tumours The term myeloma is misleading and that of myeloid sarcoma doubly so and the more accurate term osteoclastoma is adopted here



Fig. 31

The upper end of a tibia replaced by an osteoclastoma, the hæmorrhagic appearance of which is well seen

Osteoclastomata are formed in the long bones, the sternal end of the clavicle and the jaws They are especially common in the upper end of the tibia lower end of the femur lower end of the radius upper end of the humerus and in the jaws. The cut surface is hæmorrhagic, partly yellow and partly dark red in colour and cysts filled with blood clot are commonly seen (Fig 31) Microscopically the appearances are characteristic the giant cells being very numerous varying in size and containing large oval nuclei, which are scattered irregularly throughout the plasma. They lie in a stroma of oval or spindle-shaped mononuclear cells and numerous small blood vessels are present (Fig 32)

Those tumours begin in the interior of the bone and the cancellous tissue is slowly eroded the bone being thinned and expanded until finally the growth erupts through it and pushes its way into the soft tissues They are generally regarded as benign tumours although a few cases of metastases are on record.



Fig 32

Section of an osteoclastoma of the femur showing the multi-nucleated giant cells. (Keith.)

The Myeloid Epulis is an *osteoclastoma* which occurs in the jaws and arises from the bone immediately beneath the periosteum (Fig 33) It appears as a reddish soft swelling beneath the mucous membrane of the alveolar margin often in close relationship to one or two teeth (p 330)



Fig. 33

Section of a myeloid epulis of the jaw The giant cells are seen encroaching upon the subepithelial connective tissue (Keith)

Treatment depends on the size of the growth the degree of involvement of the bone and the bone affected In early cases in which the stability of the bone is not seriously destroyed, local excision of the tumour and of the affected area of bone should suffice When the growth has destroyed the bone extensively a resection of that part of the bone should be carried out and a graft put in to replace it This procedure will give excellent results in the upper extremity In the lower limb such an operation may be impracticable without leaving an unstable and useless limb in which case an amputation should be performed

Multiple Myelomatosis is a rare disease Multiple greyish white tumours occur throughout the whole bony system—the

ribs, sternum skull and small bones of the hands and feet being especially affected Many of these may appear simultaneously or one tumour may be present for some time and later be followed by others throughout the skeleton The pathology of these tumours is still undecided the typical giant cells of the osteoclastoma are absent and the stroma is far more suggestive of a sarcomatous process. The view obtaining most support at present is that these tumours are plasma celled sarcomata They are often accompanied by the presence of Bence-Jones albumose in the urine and by a positive Wassermann reaction but this is not constantly present In their late stages pyrexial attacks may occur

MYOMA

Myomata are tumours of muscle and are of two types the leiomyoma of smooth and the rhabdomyoma of striped muscle

Leiomyomata may theoretically occur in any part of the body in which smooth muscle exists, but actually they assume great importance only owing to their frequent occurrence in the uterus as *fibroids* They form rounded and encapsuled tumours which on cross-section are very tough, ivory white or pinky white in colour and resemble a fibroma having the same whorled appearance Microscopically they consist of interlacing bundles of smooth muscle fibres and fibrous tissue the relative amounts of which vary greatly in different tumours.

Rhabdomyomata are exceedingly rare and it is doubtful if a properly authenticated case is on record They have been described in the oesophagus kidney tongue and skeletal muscle Striated muscle is seen in some teratomata and in teratoblastomata and rhabdomyosarcomata are recognised especially in the kidney

NEUROMA

True neuromata are rare Amputation neuromata (Chap LI) and neurofibromata (p 90) are not true new growths of nerve tissue. Certain rare tumours in connection with the sympathetic ganglia the medulla of the suprarenal gland and the central nervous system are described as ganglioneuromata and neuroblastomata but these are not pure nerve tumours being mixtures of neural tissues of many types

GLIOMA

Gliomata arise from the supporting tissue of the central nervous system the neuroglia which although it is developed from epiblast has taken on the characters of connective tissue and the gliomata are regarded as tumours of connective-tissue origin yet their occasional resemblance to epithelial tumours sometimes makes diagnosis difficult. They may be found in any part of the central nervous system or its derivatives but the majority occur in the brain

Four varieties are described A **Medulloblastoma** occurs in the cerebellum of young children sometimes obstructing the fourth ventricle and thereby causing hydrocephalus It resembles a small round-celled sarcoma but its cells are oval and have a pseudo-rosette appearance

Spongioblastoma multiforme is a rapid growth of the neurospongium occurring in the cerebrum of middle-aged people It consists of large irregular cells with little intercellular substance multiple cystic degenerative changes being often seen

Oligodendroglioma is a less common lesion in the frontal lobe

Astrocytoma is a lesion of early life derived from mature glial cells It is composed of small glial cells with a rather dense network of fibrils

These tumours occur only in the brain and spinal cord and their pathological characteristics place them in the category of innocent tumours Nevertheless they are particularly lethal owing to their compression of the brain or involvement of vital centres in the hind brain.

THE MALIGNANT CONNECTIVE-TISSUE TUMOURS

SARCOMA

Sarcomata are malignant tumours derived from connective tissue and are characterised by the embryonic nature of the cells rapidity of their growth infiltration of surrounding tissues and their widespread

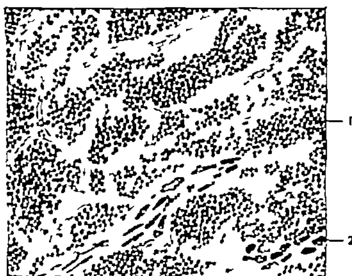


FIG. 34
Section of a small round-celled sarcoma invading muscle
(1) Sarcoma cells, ( ) muscle fibres. (Kettle.)

dissemination. Their histological picture often presents great difficulties in diagnosis, for they bear a marked resemblance to the processes of inflammation and repair

They are composed of actively growing undifferentiated cells which are scattered diffusely throughout the growth in an intercellular matrix and have little supporting stroma The vitality of the cells is shown by the numerous typical and atypical mitoses present in their nuclei

The blood vessels of such growths are poorly formed and consist of blood spaces and tubes lined by a single layer of endothelium These

lie in close contact with the cells of the tumour and the fragility of the blood vessels is responsible for the hæmorrhages which so frequently complicate sarcomata and for the early and rapid dissemination by the venous blood stream which accounts for the frequency of pulmonary metastases in these tumours Spread also occurs by local infiltration and by lymphatic permeation and embolism

Degenerative changes are very frequent in sarcomata owing to the rapid growth and to the delicacy of the blood vessels Hæmorrhage into the tumour, areas of quiet necrosis and fatty degeneration are common and myxomatous degeneration is seen in some fibrosarcomata

CLASSIFICATION —It is not possible to adopt a purely histogenetic classification for the cells are often too undifferentiated for their origin to be recognised It is customary therefore to group them according to the shape of their cell

1 Round-celled sarcoma—large and small
2. Spindle-celled sarcoma—large and small
3 Oat-celled sarcoma
4 Giant-celled sarcoma

Other types present such features that their origin cannot be doubt e g

5 Fibrosarcoma	8 Osteosarcoma.
6. Myxosarcoma	9 Lymphosarcoma.
7 Chondrosarcoma	10 Myosarcoma

Small Round-celled Sarcomata are the most malignant of tumours They are composed of small round cells closely resembling the lymphocyte of the blood being slightly larger and having a more deeply staining nucleus (Fig 34) These tumours are highly vascular and usually exhibit degenerative changes, hæmorrhage and necrosis They disseminate rapidly by the blood stream metastases appearing in all parts of the body and death occurs within a few weeks or months These tumours may arise anywhere in the body and there is often nothing to indicate their exact origin though they seem to show a predilection for the fascia covering muscles (Fig 35)



FIG. 35

A large fungating sarcoma of the buttock.

Large Round-celled Sarcomata are composed of larger cells than the preceding variety and their matrix and stroma are more clearly defined They occur in the skin the muscles and many of the viscera and in addition to widespread vascular dissemination they give rise to an enlargement of the neighbouring lymph glands

Spindle-celled Sarcomata are composed of fusiform cells which vary greatly in length and breadth but which possess a single

ral nucleus (Fig 36) These cells are grouped in bundles which rm a fine interlacing network and so intimate is their relationship ı the blood vessels that they appear to form the walls of blood aces. These growths form large solid tumours having so well efined a margin that they appear to be *encapsuled* *Hæmorrhage* : not a usual complication but they tend to undergo advanced ıucoid degeneration They are formed in all parts of the body he smaller-celled type arising in the connective tissues generally hile the larger-celled type is associated with periosteum and smooth ıuscle

Oat-celled Sarcomata are midway in both appearance and behaviour

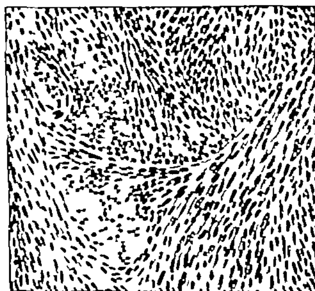


FIG. 36

Section of a spindle-celled sarcoma. (*Keith.*)

between the round and the spindle-celled types They are met with in muscle sheaths periosteum and connective tissues of viscera

Polymorphic and Giant-celled Sarcomata exhibit a remarkable *variation in the size and shape of their cells* some of which are multi nucleated giant cells They occur in bones and other parts of the body but in their general behaviour they differ little from the spindle-celled variety

Fibrosarcomata are slowly growing infiltrating tumours which give rise to metastases very late They form spindle-shaped swellings and often become soft from œdema and myxomatous degeneration

Myxosarcomata.—The majority of tumours thus named are in reality examples of myxomatous degeneration in pure sarcomata such a change being common in spindle-celled fibrosarcomata The true myxosarcoma is very rare highly malignant and forms metastases rapidly

Chondro-sarcomata are derived from cartilage and are seen in connection with bone or normally existing cartilage ...

tumours, which appear to be simple chondromata and they vary greatly in their degree of malignancy in some tumours the sarcomatous elements predominate while in others these need to be searched for in the peripheral parts of the tumour They neither grow rapidly nor disseminate widely or early

Osteosarcomata vary widely in their histological [illegible] (Fig 37) some consisting almost entirely of bone others being [illegible] devoid of it and their metastases vary similarly in the [illegible] of bone they pro[illegible] Dissemination may likewise be either early and extensive or late and slight

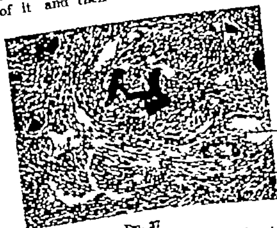


FIG. 37

Section of an osteosarcoma. (1) Spicules of bone in (2) sarcomatous tissue (Keith)

Lymphosarcomata bear certain resemblance to round-celled sarcomata, but differ from them in some important respects They arise in lymphoid tissue most commonly in that of the intestinal canal mediastinum tonsil and cervical glands They form large round firm tumours which have a homogeneous appearance on section They infiltrate locally and form metastases only in the neighbouring lymph glands Microscopically they consist of small round cells with a well marked capillary blood supply and a definite though delicate intercellular fibrous framework which will distinguish them from the round celled sarcomata The mediastinal tumours may possibly arise in remains of the thymus

The intestinal growths spread in the submucous coat and do not ulcerate but invading the adjacent lymph glands form a large tumour While this remains localised a drastic removal holds out some hope of success. (See also p 307)

Myosarcomata are of two types derived from either smooth or striated muscle

LEIOMYOSARCOMATA are occasionally met with in the alimentary canal. The cells are arranged in bundles and a longitudinal striation may be seen They are highly malignant tumours forming metastases both in lymph glands and solid viscera

RHABDOMYOSARCOMATA are rare tumours the essential histological feature of which is the cross-striation and this may be difficult to demonstrate [illegible] muscle is sometimes found in a teratoma

TH[illegible] NT EPITHELIAL TUMOURS

lial [illegible] mbranes to the many surfaces and [illegible] tructures derived from them [illegible] or as a solid gland the

epithelial cells are always in contact with one another and there is no intercellular substance as is present in all connective tissues These cells are enabled to assume a distinctive arrangement in different parts of the body from the presence of a supporting scaffold of connective tissue which also transmits the blood and lymph vessels It is evident that a pure epithelial growth cannot occur because in every case the stroma must keep pace with the epithelium but it is the proliferation of the epithelium which is of prime importance in these tumours and for this reason it is simpler and less confusing to refer to them as epithelial tumours

The innocent epithelial tumours always reproduce though atypically the structure of the parent epithelium two types therefore exist the papilloma growing from surface cells and the adenoma arising in glandular or secreting cells Papillomata always grow away from the surface the cells being arranged around a central core of vascular connective tissue adenomata grow beneath the surface in solid or tubular masses In the latter group the tubules may dilate to form cysts into which papillomatous processes can grow giving rise to a papillary cyst adenoma

These two groups conform to certain general principles of behaviour They progress slowly they neither infiltrate nor disseminate their cells retain a close resemblance to the normal and they possess a well-defined blood supply Degenerative changes are not usual, and are more in the nature of an excess or a perversion of the normal physiological activity of the cells For example the horny degeneration' in a papilloma of the skin is merely an excessive production of keratin and the over-activity of an adenoma results in a colloid or mucoid degeneration. In very slowly growing adenomata, fatty myxomatous hyaline and even calcareous changes may be seen Papillomata are liable to inflammation and ulceration Finally both adenoma and papilloma may undergo a carcinomatous change especially the latter which many observers regard as a precancerous condition in certain situations *e.g* the urinary bladder and the breast

PAPILLOMA

Papillomata of the skin or warts (Fig 38) are hard tumours with a broad base of attachment to the skin Their surface is fissured but the processes are always short They are frequently multiple often show pigmentation and may form a horn from excessive keratinisation

Papillomata of a mucous surface present a villous appearance being composed of long delicate processes arising from a central stalk. They are commonly seen in the urinary bladder where they are very soft and bear a striking resemblance to certain forms of seaweed. Another type occurs in the intestines consisting of single thick, finger like processes hundreds of which may be present in the condition known as colitis polyposa

Intracystic papillomata are seen in cysts of the ovary breast and thyroid and vary in structure from coarse branching growths to fine delicate villous processes

Microscopically papillomata consist of a core of vascular connective tissue around which is grouped one or more layers of cells of the same type as the epithelium from which the tumour is growing Secondary outgrowths of epithelium and stroma from the main stem will give



Fig 33
A papilloma of the skin.

rise to a complex compound papilloma but the essential structure remains unchanged Many papillomatous processes are not true new growths but are infective in origin *e.g* the multiple venereal warts of the external genital organs and molluscum contagiosum

ADENOMA

Adenomata are encapsuled tumours composed of epithelial cells which in size shape and arrangement closely resemble the normal tissue from which they arise and further show a remarkable tendency to reproduce the function of their parent cells Since adenomata may occur in any glandular structure in the body they will present a very varied structure The histological characteristics of the individual adenomata will be found in the chapters on each region of the body and only those characteristics common to them all will be described here

The mode of growth of adenomata depends partly on their site of origin and partly on their parent tissue those arising from the substance of a gland are spherical and encapsuled and are known as

intraglandular while those growing from a mucous surface are polypoid pear-shaped and pedunculated Adenomata of solid organs *e.g* the liver are composed of solid masses of cells arranged in trabeculæ or solid alveoli whereas those of tubular glands have an acinous arrangement This distinction is not absolute and both types may be seen in the same tumour

The power of reproducing the function of the parent tissue is the most important feature of adenomata those of the liver producing bile those of the thyroid colloid and those of the intestinal canal mucin Since these tumours possess no outlet for the disposal of their secretion their arrangement must become modified by the distension of their acini with retained secretion and in this way cysts will be formed throughout the tumour which is then named a cystadenoma The cells lining these cysts may either atrophy from pressure or continue active growth into the lumen of the acini thus forming the papillary cystadenomata seen in the breast thyroid and ovary

The part played by the supporting connective tissue in these tumours has already been explained but in certain situations there is a definitely co-existing growth of the fibrous tissue Examples of this type of compound growth will be met with in several organs a notable example being the fibro-adenoma of the breast The exact pathological classification of such tumours is not always easy

THE MALIGNANT EPITHELIAL TUMOURS

CARCINOMA

Carcinomata are malignant tumours derived from epithelial cells Their structure is more complicated than that of the sarcomata for their supporting connective tissue stroma and its blood vessels play an important part in their life history

The epithelial cells vary greatly in their arrangement for in some tumours they tend to form glandular alveoli acini and tubules or to assume a papillary form while in others the cells revert to a more embryonic type and a closely packed mass of undifferentiated cells results Generally speaking the more rapidly a carcinoma grows the more will its cells deviate from normal and the less likely is it to assume any recognisable form.

The stroma consists of a fibrous connective tissue with blood vessels and varies widely in different tumours. A carcinoma arising in an organ with a well marked fibrous framework—*e.g* the breast—is likely to have an abundant stroma whereas the reverse is equally true as is seen in the primary carcinoma of the liver A far more important factor however in the production of stroma is the rapidity of the growth of the epithelial cells Where this is very slow the stroma is given time to become abundant and so dense may it be that an area of slowly growing tumour cells is so completely surrounded as virtually to constitute a natural cure *e.g* an atrophic scirrhus but when the epithelial growth is vigorous and unrestrained the stroma will be represented only by a network of delicate capillary blood

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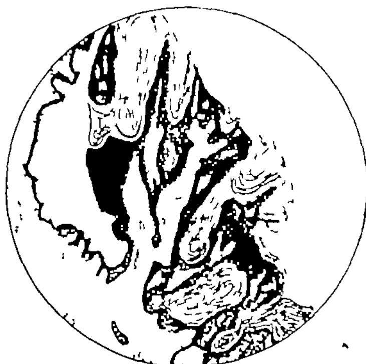


FIG. 38
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vessels e.g an encephaloid carcinoma of the breast. In a great many tumours the stroma contains a round-celled infiltration of lymphocytes plasma cells and an occasional eosinophil. This adventitious cell infiltration is to be regarded as the body's attempt at defence against the growth

The naked-eye appearances gross structure and microscopical characters are too variable to allow a generalised description and each growth will be set out in detail in regional sections of this book.

Carcinomata may be divided into two main groups (1) those arising in lining or protective membranes and (2) those arising from glandular epithelium

CARCINOMA OF LINING OR PROTECTIVE EPITHELIUM

These tumours arise from the skin, mouth, pharynx, œsophagus bladder ureter and renal pelvis, vagina and cervix uteri They grow



FIG. 39
An ulcerating squamous-celled carcinoma of the tongue.

from squamous or transitional epithelium and are all classed as squamous-celled carcinomata though their appearance differs according to the complexity or simplicity of their parent epithelium.

Squamous-celled Carcinomata of the skin lips mouth and tongue (Fig 39) are both characteristic and consistent in their appearances Branching columns of epithelial cells penetrate the underlying tissues The outer cells of these processes are small, deeply staining and exhibit intracellular protoplasmic bridges from which the name prickle cell is derived the more central cells are larger less deeply staining and contain eleidin granules while the most central i.e the oldest cells, are completely degenerate and are converted into areas of keratin These are the cell nests or epithelial pearls which are so characteristic a feature of squamous-celled carcinoma (Fig 40) The extent of this keratinisation is made use of by some pathologists to grade these tumours according to their relative malignancy Absence of cell nests is regarded as a sign of rapid growth whereas profuse keratinisation is evidence of low malignancy



FIG 40

Section showing a squamous-celled carcinoma of the tongue. The epithelial processes are seen to be infiltrating the subepithelial connective tissue and many cell nests are present



FIG 41

Prickle cells eleidin granules and cell nests are not seen in many of the growths in the œsophagus pharynx and antrum of Highmore in which the cells may be drawn out and compressed into a spindle form Growths of the bladder ureter and renal pelvis also do not show prickle cells or cell nests being sometimes known as **transitional-celled carcinomata.**

Rodent Ulcer or basal-celled carcinoma of the skin consists of a large collection of oval or spindle cells surrounded by an external layer of high columnar cells—the pallisade layer (Fig 41) The exact origin of these tumours is still undecided (p 237)

A squamous-celled carcinoma is occasionally seen arising from a columnar or cubical epithelium *e.g* in the gall bladder and body of the uterus This is an example of metaplasia *i e* a reversion of cells to a less highly differentiated type

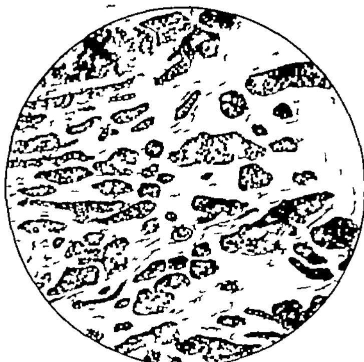


Fig 42

Section of a carcinoma simplex of the breast.

CARCINOMA OF GLANDULAR EPITHELIUM

These tumours fall into two groups the carcinoma simplex and the glandular carcinoma of more highly differentiated cells

Carcinoma Simplex or spheroidal-celled carcinoma consists of masses of densely packed cells which are moulded into polygonal or irregular forms The cells have a deeply staining granular cytoplasm and a nucleus with well marked chromatin They may be arranged in long slender processes (as at the limit of infiltration)

or in short broad columns or they may be grouped together in solid alveoli The stroma varies greatly depending on the rapidity of the epithelial growth and the efficiency of the host s reaction (*vide* p 84) This variation in the stroma justifies the division of these carcinomata into two groups viz. encephaloid and scirrhus the former having little the latter a relative large proportion of fibrous tissue Carcinoma simplex may arise in many glandular tissues but it can be most perfectly studied in the breast (Fig 42)

Glandular Carcinoma is derived from highly differentiated cells of complex glandular structure The arrangement of such carcinoma cells depends on their rate of growth and on the type of the parent epithelium. The more slowly growing tumours attempt to reproduce the form and shape of the glands from which they have grown and their cells may even reproduce the function of their parent cells *e.g.*, the presence of mucus-secreting goblet cells in an adeno-carcinoma of the rectum The result is a very varied structure in different types of glandular carcinoma combined with a somewhat confusing nomenclature Adeno-carcinoma papillary adeno-carcinoma adenoma malignum duct carcinoma and columnar-celled carcinoma are merely expressions of the type of growth concerned and more than one type is often seen in the same tumour

The cells may be columnar or cubical they tend to be smaller than normal and their nuclei are larger and more deeply stained. The acini vary in size and shape being lined with one or several layers of cells Cysts may form and papillary processes project into them

HYPERNEPHROMA

Hypernephromata form a group of malignant epithelial tumours whose characteristics are so striking as to justify a separate description

The great majority of them occur in the kidney but there are rare examples in the testis and along the course of the ureter and elsewhere Their nature has been the subject of much controversy for their resemblance to the zona fasciculata of the adrenal gland has led to many theories of embryonic origin Grawitz having demonstrated the existence of adrenal rests' or misplaced islands of adrenal cells beneath the capsule of the kidney suggested that hypernephromata arose in these rests Others (Willis and Wilson) have favoured the theory that similar rests of Wolffian body cells are responsible but at the present time it is generally accepted that this tumour arises from the renal tubules and must be classified as a highly specialised atypical carcinoma of the kidney

Its macroscopic appearance is so characteristic that a diagnosis may confidently be made in most cases The tumour usually starts at the upper or the lower pole or occasionally in the middle zone and for a long time the normal structure of one or other pole remains clearly recognisable The cut surface which shows apparent encapsulation is partly golden yellow in colour and partly mottled with large or small areas of extravasated blood well marked striæ of fibrosis appear to divide the tumour into lobules some of which may be degenerate even

to the point of cyst formation The tumour cells may invade the re pelvis and the renal vein is often found full of growth (vide Fig) p 780)

Microscopically a frozen section stained with Sudan III Sharlach R shows the cells to be distended with lipoid. In para sections the cells are large and polygonal with clear faintly stain and vacuolated cytoplasm and a well-stained nucleus They may arranged in a variety ways The tumour r consist of solid trabec of cells closely related the blood spaces and ca laries of a tubular or acin growth or frequently the c are arranged in a pap matous manner round vascular core The str is slight the cells resting the vascular spaces w may be lined with only layer of endothelial (Fig 43)

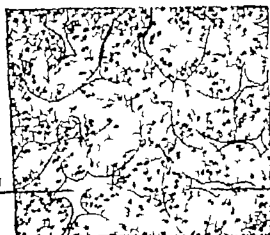


Fig. 43

Section of a hypernephroma of the kidney The pale clear cells are well shown bearing an intimate relationship to the vascular spaces (I). (Keith)

Dissemination occurs chiefly by the renal vein and metastases are found in the lungs and long bones Many examples are recorde of secondaries appearing i bones before the primary growth was clinically demonstrable.

MELANOMA

The melanomata are characterised by the presence of an iron fre sulphur containing pigment named melanin They arise from th skin and the choroid coat of the eye

Benign Melanomata of the skin are known as pigmented moles which are small black or brown tumours of the skin with either a thi epithelial covering or a papillomatous surface They consist o collections of small rounded pigmented cells lying in a dense fibrou stroma The amount of pigment varies being sparse in some tumours and profuse in others

Malignant Melanomata may arise in a pre-existing pigmented mole may follow a blow or wound or start spontaneously in the eye The tumours grow at a great rate and form metastases all over th body The amount of pigment in the primary and secondary growth varies greatly some being grey others jet black and others quit colourless (Fig 44)

Microscopically two types exist In the first the appearance i that of a spindle-celled sarcoma with little specks of melanin scattered throughout it This type is the melanotic sarcoma arising in th

-romatophore cells of the connective tissue and disseminating by e blood stream The second type consists of pigment bearing cells ranged in acini, strongly suggesting an epithelial tumour This is the elano-carcinoma derived from the pigmented cells of the rete malpighii the epidermis and spreading primarily by the lymphatics (Fig 45)

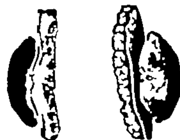


FIG 44

Two views of a malignant melanoma of the skin showing the jet-black ppearance on cross section and the greyish ulcerated exterior



FIG 45

Section of pigmented mole. The heavy deposit of pigment can be seen both in the cells and in the stroma. (*Kettle.*)

ENDOTHELIOMA

The complex nature of the endotheliomata carries them beyond he scope of this book. The position is admirably stated by Kettle n his Pathology of Tumours

Vascular Endotheliomata (p 293) include —

1 CAPILLARY ANGIOMA occurring in the skin as a congenital malformation resulting in the familiar birth mark " or port wine stain.
2 CAVERNOUS ANGIOMA of the liver and subcutaneous tissue also of congenital origin
3 HÆMANGIOMA SIMPLEX which occurs in the subcutaneous tissues and infiltrates the underlying muscle It is a true new growth of vascular endothelium
4 GLOMANGIOMA a highly specialised tumour arising in a glomus " body of the skin (p 295)

Lymphatic Endotheliomata are —

1 SIMPLE LYMPHANGIECTASIS of the skin of the face and neck, of congenital origin
2 CYSTIC LYMPHANGIECTASIS as seen in the cystic hygroma of the neck (pp 298 and 370)
3 CAVERNOUS LYMPHANGIOMA which is the underlying cause of diffuse enlargement of the lips and tongue viz macrocheilia and macroglossia (pp 314 and 34)

Endotheliomata of Serous Membranes are rare the best example being the *meningioma* or *psammoma* of the dura mater This consists

of cells of endothelial origin which have a whorled arrangem Hard gritty nodules are formed in them by the deposition of calc salts

TERATOMA

The teratomata differ from all other tumours in that they cont tissues formed from two or three of the primary layers of the develop embryo They are the result of the cells of one individual grow within the body of another of the same species

True teratomata are found in the ovary and testis others be



Fig. 46

A se tion of t ratoma of the ary showing epithel um, (2) cartilage (3) fat (4) osteoid tissue smooth mu le fibre (6) glandular tissue

Testicular Teratomata are usually solid Their appearance varies considerably but in the majority the tumour seems to be encapsuled and a fine layer of compressed testicular tissue may be seen stretched over its surface In many examples numerous small cysts are scattered throughout the growth while in others there is so much cartilage present that it can be recognised by the naked eye The testicular dermoid is an exceedingly rare form The histological findings are similar to those of the ovarian tumours tissues of every variety being mixed up together

Teratomata are always potentially malignant but they may behave as innocent tumours for many months The heterogeneous mixture of tissues gives the suggestion of instability in these tumours and hence it is not surprising that carcinoma and sarcoma may arise in teratomatous cells and both may be found in the same tumour When metastases occur they may reproduce the multiplicity of tissues but more frequently one type of cell predominates and it may be



FIG. 47

A sacrococcygeal tumour Mr V Pennell's case.

impossible to diagnose the nature of the primary tumour from the histology of the metastases

Sacrococcygeal Teratoma is a solid tumour arising from the postero-inferior aspects of the sacro iliac region Its appearance varies from a fully formed Siamese twin to a rounded tumour containing either perfectly formed structures or more likely a heterogeneous mixture of cells of all types The specimen illustrated (Fig 47) contained a primitive œsophagus stomach and intestine together with a plaque of bone and a quantity of nerve tissue

Epignathus is a similar condition arising from the region of the nasal bones

Teratoblastomata contain representative cells of two primary layers only They are seen chiefly in the kidney as the ' mixed tumour of infants They arise from *rests* of the primitive segments of the body and grow from the region of the hilum of the kidney which is spread out over the tumour as a thin compressed layer They are greyish in colour often homogeneous throughout or sometimes mottled with areas of extravasated blood Microscopically there is a densely cellular structure of small round cells supporting irregular tubules lined with columnar epithelium and both smooth and striated muscle bundles These tumours are very malignant and rapidly form metastases

Chorionic Carcinoma differs from all other tumours in that it is

the product of a highly specialised tissue of another individual and *is therefore* in the nature of a teratoma, although it is composed of cells derived from one source only It is an atypical growth of the cells of the trophoblast of the developing ovum and is therefore associated with pregnancy and in the great majority of cases it follows either an abortion or a hydatidiform mole The ovary fallopian tubes and vagina may be affected as well as the uterus It disseminates by the blood stream and is one of the most rapidly fatal tumours known though it has been reported as clearing up spontaneously and after removal of the primary growth secondary deposits are said to have faded away It gives a strongly positive Aschheim-Zondek reaction.

The tumour is a dark red fleshy friable mass Microscopically there are two *distinct types of cell bearing a close resemblance* in appearance and behaviour to those of normal chorionic villi. The Langhans cells are polygonal and have a lightly staining cytoplasm and well-defined nucleus while the syncytium is composed of protoplasm without cell boundaries stains very deeply and contains numbers of even more deeply staining nuclei. The Langhans cells form closely packed aggregates with the syncytium either around them or scattered irregularly through them The tumour is devoid of stroma and derives its nutrition direct from the blood of the host

Chorionic carcinoma has been recorded in teratomata of the testicle an observation which has had a profound bearing on the nature of the teratomata.

CYSTS

Cysts are met with in many pathological conditions and the term " cyst " applied clinically should refer only to those swellings in which there is a collection of fluid in a sac which has a lining membrane

They may be classified as follows —

A Congenital	Dermoid cysts Embryonic persistence cysts.
B Acquired	Distension cysts Cysts of new formation Degeneration cysts Traumatic cysts
C Parasitic.	

CONGENITAL CYSTS

Dermoid Cysts are of two varieties viz the sequestration and the tubulo-dermoid. The so-called dermoid cysts of the ovary and testis are products of teratomata

Sequestration Dermoids are formed by the inclusion of cells of the epiblast beneath the surface at any situation in the body where lines of developing skin meet and join. They may be seen therefore anywhere in the middle line of the body surface in the face along the lines of junction of the maxillary and lateral nasal processes and in the lateral aspects of the neck from the branchial clefts The mor

common sites are at the outer margin of the orbit near the outer canthus at the root of the nose in the midline of the submental region and in the anterior triangle of the neck (branchial cyst p 362)

These cysts are attached to the deep structures but the skin moves freely over them They should be excised

TUBULO-DERMOIDS arise in connection with embryonic glands and ducts which should normally disappear They are represented by thyroglossal cysts (p. 362) and those behind the rectum which are derived from the post anal gut

Embryonic Persistence Cysts arise from specialised embryonic structures which should normally disappear completely or remain only as small vestigial remnants

In the male cysts arise in the remnants of the Wolffian body and duct, viz., the organ of Giraldes of the spermatic cord and the vas aberrans of Haller in the epididymis or from the representatives of the Müllerian duct, viz the hydatids of Morgagni, or again from the persistence of the central part of the processus vaginalis from which is derived the encysted hydrocele of the cord.

In the female cysts of Wolffian origin are those in the broad ligament in the organ of Rosenmüller from Kobelt s tubules and in Gärtner s duct A persistent canal of Nuck gives rise to a hydrocele of the round ligament

ACQUIRED CYSTS

Distension Cysts.—EXUDATION CYSTS are the result of either trauma or inflammation in pre-existing cavities and should not be included among true cysts

RETENTION CYSTS are due to the retention of the normal secretion of a gland from an obstruction of its duct Numerous examples will be described in the breast pancreas salivary glands etc

Cysts of New Formation.—IMPLANTATION CYSTS—sometimes named implantation dermoids—are due to the implantation of squamous epithelial cells in the subcutaneous tissues by penetrating wounds of either sharp or blunt instruments Their vitality being unimpaired, these cells continue to grow until a cyst is formed, lined by squamous epithelium and containing degenerate keratinised debris They are usually seen in the hand, excellent examples being those in the fingers of seamstresses Foreign body cysts may be formed around a retained and encapsuled foreign body being lined with endothelium and having a fibrous capsule

Degeneration Cysts.—Cysts may occur in tumours either as the result of hæmorrhage or from liquefactive necrosis due to an inadequate blood supply Certain rapidly growing sarcomata with a pseudo-capsule contain large quantities of clear fluid.

Traumatic Cysts.—Injury in certain parts of the body *e.g* the lumbar and lumbosacral regions of the back and the antero-external part of the thigh is sometimes followed by a large collection of fluid blood between the subcutaneous tissues and the deep fascia. Absorption and resolution do not always follow and if the fluid blood is not removed by aspiration, a post traumatic serous cyst will form

If left sufficiently long the walls of the cavity will become lined by endothelium, and the cyst will be extremely difficult to eradicate

PARASITIC CYSTS

Echinococcal (or Hydatid) Cysts are the most important of this type of cyst in the human body and are the intermediate stage in the life history of the TÆNIA ECHINOCOCCUS The disease is much more common in Australasia but is occasionally endemic in this country The adult worm which inhabits the small intestine of the dog or wolf is ¼ in. long and is composed of four segments The head is armed with four suckers and forty hooklets in two rows while the tail segment contains the reproductive organs and is equal in length to the other three together (Fig 48)

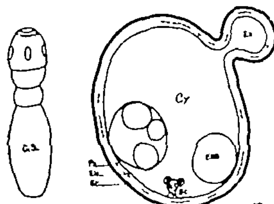


FIG. 48

A diagram representing on the left the *Tænia echinococcus* and on the right the hydatid cyst.

Cy Ex., the exogenous, and End., endogenous cyst; Ps., pseudo-cyst; Ec., the ecto-cyst; En., the endo-cyst; Bc., a brood capsule surmounted in this case by two scolices; *G.S* germinal segment.

The ovum is roughly one and a half times the size of a human red blood cell, is enclosed in a chitinous envelope and bears three pairs of hook lets. Having been ex creted from the dog, it gains entrance to the human being by water or green uncooked vegetables such as watercress In the stomach its envelope is digested and the ovum anchors itself to the gastric mucous membrane and erodes its way into a radicle of the portal vein, whence it is carried to the liver Here the majority are arrested and settle down to form a hydatid cyst of the liver but some pass through the liver capillaries and enter the general circulation to be filtered out by a capillary system in any part of the body *e g* in the lungs kidneys or long bones. Fig 49 shows a large hydatid cyst of the liver

The hydatid cyst is composed of three layers an outer or pseudo-cyst being derived from the host by compression of the surrounding tissues a middle or *ecto-cyst* and an inner or endo-cyst The ecto-cyst is a chitinous covering to the epithelial or generative endo-cyst which buds off daughter and granddaughter cysts In these cysts little fleshy processes develop known as brood capsules from which are developed the *scolices* A scolex is the head segment of a future worm so arranged that its suckers and hooklets face into a central recess or sinus The contents of the cyst are clear fluid of sp gr 1002 to 1004 inorganic salts a trace of pyrocatechin (a sugar reducing agent) hooklets and scolices

The cyst may continue to grow to great size or certain complications may follow The parasite may die in which case the fluid is absorbed, the contents become a pultaceous mass which after a long time will become calcified. The cyst may become infected and an abscess will form or it may rupture into related serous sacs *e.g* the peritoneum and the daughter cysts will be implanted over their surface or into the duct of a gland as in the case of the pelvis of the kidney

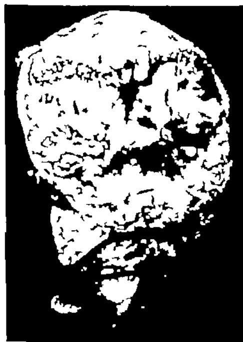


FIG. 49
A large hydatid cyst of the liver containing many daughter cysts.

Diagnosis is made by the Casoni intradermal test a complement fixation test and an eosinophilia in the blood. Aspiration of the fluid contents should never be practised

Treatment is complete removal wherever possible failing which the cyst should be marsupialised to the skin and later opened and irrigated with formalin.

Other parasites which cause cysts in the human being are the *Trichina spiralis* and the intermediate stage of *T solium* (p 52)

R M HANDFIELD-JONES

CHAPTER VII

WOUNDS AND BURNS

WOUNDS

A WOUND is defined as a forcible solution of continuity in soft tissues Such an injury may be classified in many ways and there is a tendency to describe wounds of war and peace as if they belonged to entirely different categories Essentially their pathology clinical features and treatment are identical and no good purpose can be served by keeping them apart The following classification covers both types —

A Closed or non penetrating	Contusion Hæmatoma Abrasion
B Open or penetrating	Incision, stab or puncture Simple penetration without exit Laceration. Perforating *i.e.* with exit Disruption or blast

NON-PENETRATING WOUNDS

Closed wounds are those which do not penetrate the whole thickness of the skin

A Contusion is produced by applied violence usually with a blunt instrument as a result of which there occurs a rupture of blood vessels and a varying amount of damage to sort tissues beneath the skin If the resultant hæmorrhage extravasates in the skin and underlying soft parts an *ecchymosis* or *bruise* forms

Its clinical signs and symptoms are pain, discoloration and swelling Pain and swelling vary inversely according to the tissue damaged, the more lax structures exhibiting little of the former and much of the latter Thus a contusion of the eyelids and scrotum results in consider able swelling and little pain whereas the opposite holds good in the fingers and scalp The *discoloration* is due to the disintegration of red blood cells and liberation of hæmoglobin the nearer the surface the contusion occurs the sooner does the discoloration appear and the more evident it is The colour is at first a deep purple black, changes to purple blue red brown green and finally fades aw in a yellowish tint within fourteen to twenty-one days These c about by the chemical processes through

during its preparation for final absorption The colours are due to bilirubin, biliverdin, hæmatoidin and hæmosiderin. When the contusion occurs in deeper planes swelling and discoloration may appear at the surface some considerable distance from the initial injury

A Hæmatoma is formed when blood is poured out in greater quantities and especially when its diffusion is prevented by fascial planes and muscle attachments In the first few days it presents a rounded fluctuating swelling resembling an abscess in certain respects Unlike an abscess which is at first hard and then softens the hæmatoma soon acquires a boggy and then a hard edge This is the beginning of the process of organisation (p 5) which may lead to complete absorption. Not all clots however achieve this happy ending some leave evidence of their presence in the form of a hard fibrous scar while others give rise to "serous cysts These latter occur on the surface of the brain being known there as arachnoid cysts and in the lumbar region, upper part of the buttock and the antero-lateral aspect of the thigh Fibrin having been deposited at the periphery and the hæmoglobin having been removed, a cyst filled with clear pale yellow serum is formed. In the absence of treatment this cyst rapidly gains an endothelial lining and its removal may prove an extensive and difficult business.

It will be appreciated that extravasated blood is such an excellent culture medium that it is not uncommon for a hæmatoma to become infected in debilitated or toxic patients Further it should be noted that internal organs such as the brain, liver kidneys lungs and gastro intestinal tract may suffer contusion and hæmatoma formation in exactly the same way as muscle and subcutaneous tissues

Treatment —An extensive bruise or hæmatoma demands rest and the application of either evaporating lotions or heat A hot bath will relieve pain and firm pressure limits extravasation, while in the later stages massage will promote rapid absorption of the exudate If a hæmatoma is slow to resolve the fluid blood must be removed by aspiration and the parts firmly bandaged to prevent the formation of a serous cyst If it should be under such pressure as to cause great pain, evacuation of the clot through a small incision with a tenotome will give immediate relief

An Abrasion is produced by friction upon some hard or rough surface and consists merely in the removal of small areas of the epidermis As a result many superficial nerve endings are exposed and these trivial lesions are unusually painful Grit and other foreign matter is often engrained and surface sepsis is the rule Careful cleansing and the use of penicillin cream or a mild mercurial ointment is the only treatment needed An abrasion heals by granulation beneath a scab

Crush Syndrome

A special type of contused wound is that caused by prolonged compression by baulks of timber or masses of masonry Although this was recognised before this war the attention of British surgeons was forcibly drawn to it during the bombing of Britain A man was admitted

to St Mary's Hospital having been trapped under a ruined buildin[g] a large baulk of timber had pinned down his right thigh and mason[ry] had crushed his right side He was released after seventeen hour[s] and the skin subjected to pressure appeared almost dead. He w[as] surprisingly little shocked and the skin rapidly recovered but the rig[ht] leg began to swell until the skin became so tightly stretched that [it] seemed as if it must burst Twenty nine hours after admission [he] developed anuria and speedily died. Such is an example of the "Cru[sh] Syndrome Little is known of its etiology though it bears man[y] points of resemblance to the results of an incompatible blood tran[s]fusion Recent experimental work at Oxford suggests that the tox[ic] products absorbed from the crushed area exert a specific action up[on] renal circulation by which all the blood is shunted through the medull[a] thereby depriving the cortex of its normal circulation Crushed liml[s] should be treated by compression above the affected parts with [a] sphygmomanometer air cuff to delay absorption of toxic product[s] and every effort made to overcome diminishing renal function. Wo[rk] is being done upon the effect on intravenous alkalis 100 c c of 4 p[er] cent. sodium bicarbonate and 4 per cent sodium citrate being giv[en] in twenty hours The effect also of spinal anaesthesia and of splanchn[ic] nerve block are under investigation

PENETRATING WOUNDS

Open wounds are those in which a solution of continuity of skin [or] mucous membrane leads to disrupted soft tissue below There a[re] numerous varieties of such wounds but their pathology is basical[ly] the same varying only in degree We describe three stages —

1 DISRUPTION OF SOFT TISSUES occurs immediately and its exte[nt] in the various anatomical planes depends upon the nature and for[ce] of the inflicting agent Disrupted muscle fibres have lost their bloo[d] supply contractility and power to resist infection. Such muscle [is] obviously a splendid culture medium for anaerobic organisms.

2 PROTECTIVE INFLAMMATION —Very quickly the mechanism [of] inflammation is called into action (p 1) and the body mobilises i[ts] defences. The exudate causes a visible oedema and this may be [so] great in certain cases and in certain situations (*e.g* the thigh) as [to] endanger the circulation.

3 ESTABLISHED INFECTION —Every penetrating wound excep[t] those inflicted by the surgeon, is potentially infected The skin [is] unclean and particles of dirt debris and clothing are almost certain[ly] carried into the wound. For a period, not less than six and not mo[re] than twelve hours, organisms may be said to be still upon the surfa[ce] of the damaged tissues and not yet embedded and in action by whi[ch] we mean multiplying and producing toxin After this safe peri[od] the wound is definitely infected

INCISIONS, STABS AND PUNCTURES

Incised Wounds are produced by sharp cutting instruments such as knives surgical scalpels, fragments of glass etc or more rarely by blunt violence upon tightly stretched skin such as the scalp An incised

wound tends to gape (the extent depending upon the elasticity and tension of the injured tissues) its length is greater than its depth its edges are regular and there is only microscopic devitalisation of cells it bleeds freely and is painful because of the number of sensory nerves cut it is accompanied by a moderate degree of shock and if the edges are apposed it heals by first intention within a week unless infection supervenes

In all accidental incised wounds the whole extent of the track must be thoroughly explored to assess the exact amount of damage to important structures such as vessels, nerves muscles and tendons Regeneration after primary suture and in the absence of infection will be good in nerves tendons muscles and bone poor in fat and secreting glands and absent in the central nervous system

Stabs and Punctured Wounds are due to sharp-pointed instruments such as pins needles nails wood splinters bayonets and fish hooks They have a relatively small orifice and their importance lies in the fact that infection or foreign particles can be carried into the depth of the wound the opening of which is quite inadequate for drainage further damage may be done to deep structures which it is difficult to visualise

In the absence of complications punctured wounds bleed little are not painful except at the moment of infliction and heal rapidly If they become septic they must be opened and treated accordingly If a retained foreign body is suspected an antero-posterior and a lateral X ray film should be taken and its position thus determined. Fish hooks are best removed by pushing the shaft still further in so that the barb comes out through a second puncture wound.

SNAKE BITES form a subgroup of punctured wounds. In this country the adder is the only poisonous snake but in tropical parts there are many whose bites prove fatal. A snake s venom is produced in its parotid glands and is led by special ducts to the fangs thus the poison is implanted in the very depth of the wound. It is usually an albumose with a markedly acid reaction and as we have already seen (p 17) each specific venom produces an anti venom just as bacterial toxins stimulate the formation of antitoxins

Swelling pain and local discoloration are rapidly accompanied by faintness, weak pulse vomiting dilated pupils and a feeling of terror In more virulent cases collapse soon follows and death may occur within an hour Local treatment should be vigorous A tourniquet is applied immediately the wounds opened up free bleeding encouraged and the tissues irrigated with ammonia or hydrogen peroxide Brandy and heart stimulants are given meantime In districts where poisonous snakes abound anti venom is prepared against the bite of all known species. When administered within an hour of the bite this treatment has reduced the mortality to a low figure

BITES AND STINGS from bees wasps mosquitoes, certain flies lice fleas, *scorpions and spiders are also* punctured wounds. Quite apart from the importance of such lesions from the point of view of the trans mission of infectious diseases they have an intrinsic bearing upon surgical treatment The local reaction is similar to that in snake bite

and may be accompanied by an urticarial eruption The actual swelling may in certain situations be a danger to life *e.g* tongue and larynx while bites within the danger area on the face may lead to cavernous sinus thrombosis and death Treatment is by removing the sting—if possible—and dressing the wound with an alkaline solution.

LACERATED WOUNDS

The wounds of war are only too frequently of this type and even in peace time in this machine age lacerations form a considerable percentage of the whole They are produced by a tearing or bursting force and consequently are irregular in shape The skin is often less extensively injured than the underlying tissues but is commonly lifted off them over a wide area The edges are ragged and purple subcutaneous fat deep fascia and muscle are disrupted and swollen and hæmorrhage is often conspicuous by its absence This is due to tearing of the vessels and consequent retraction of the intima which assists clotting The mouth of a lacerated wound will often be found filled with clot

Injury to nerves leads to a temporary local insensibility and a dull ache may be the only complaint Primary shock is slight in many patients, but secondary shock is likely to be severe

A wound of this type is probably caused by a jagged agent and contamination is inevitable Furthermore main vessels may be involved in deep wounds and from every point of view the conditions are ideal for the rapid growth of invading organisms.

Lacerated wounds heal by granulation tissue

PENETRATING WOUNDS

These wounds have a point of entry but no exit, they may be incised punctured or lacerated They need special emphasis on account of the entirely unexpected damage they may inflict upon deep structures Many war wounds are of this type and the path traversed by bullet shell fragment or bomb splinter can only be guessed at Such foreign bodies must be localised by X ray methods and their estimated track from entrance to point of lodgment gives a reasonable picture of possible damage to intervening structures Treatment will be planned accordingly

PERFORATING WOUNDS

These wounds have points of both entry and exit They are due to missiles which still retain a high velocity and have certain advantages over penetrating wounds there is no retained foreign body and under some conditions they are less dangerous They are classified as follows —

1 Both entry and exit wounds small.
2 Entry small and exit large
3 Both large

1 Both entry and exit small Such wounds are usually caused

by high velocity bullets which pass through the body without hitting bone In rare instances the bone may be cleanly holed and the hole of exit still remain small The clinical picture depends upon the part of the body involved and the internal structures injured In the limbs the missile may pass through without traversing anything but skin muscle and fascia, and such a tunnel wound may need little attention It may sever main arteries or nerves, damage to which will be revealed by *swelling absence of distal pulsation* and loss of function. In the trunk the line between entry and exit gives an indication of which viscera may be involved

2 Wounds with a small entry and a gaping lacerated exit are almost always due to missiles fired at close range which have hit bone in their path

3 Wounds with large holes of both entry and exit are caused by big fragments of bomb or shell-casing or to a bullet which has already hit something and begun to turn over A wide extent of tissue including main vessels and nerves is likely to be destroyed and such cases will often not reach the surgeon.

DISRUPTION WOUNDS

Wounds due to blast attained a prominence in this last war owing to aerial bombing and the under water explosion of depth charges As we have seen every wound has a certain disruptive element in it but blast injuries are those in which there is no tissue penetration by any tangible foreign body Two forms have emerged both resulting from an explosive burst at fairly close quarters

Blast Injury to the Lungs.—A great quantity of clinico-pathological data was collected during aerial attacks upon this country much of it trivial some of it misleading Experiments have shown that both upon land and under water injury to the lungs has been absent or diminished if the victim has complete protection of the abdominal wall by a metal shield. The lung is not damaged—as was thought—by violent retrograde movement of air down the trachea into the bronchial tree but by forcible compression communicated to the chest by a violent displacement upwards of the diaphragm In non fatal cases air vesicles are ruptured and multiple small interstitial hæmorrhages occur A characteristic X ray film reminiscent of widespread broncho-pneumonia results Patients will complain of a tightness in the chest dyspnœa and hæmoptysis Whilst its importance as a cause of im mediate death cannot be denied, the clinical manifestations in non fatal cases have been somewhat exaggerated (see also p 475)

Blast Injury to Soft Tissues.—The findings in such a case cannot be more clearly explained than by the following report from the author s experience during the concentrated bombing of London in October 1940 Amongst a large number of severe casualties a woman of 24 years was admitted with a large lacerated wound of the left buttock. *No point of exit could be discovered but she* complained of pain in her left Scarpa s triangle She was marked Resuscitation and operation as soon as ready being very gravely shocked. As the night wore on

and as our list of immediate operation cases was being rapidly worked through by four surgical teams, I went repeatedly to the resuscitation room to check progress other cases were recovering and being sent to the theatre but nothing seemed to make any impression upon this woman. On several occasions I impressed upon my staff how important it was that she should be operated upon but it was not until twenty nine hours had elapsed that she was fit Neither at operation nor at post-mortem was a foreign body discovered, the tissues having been torn apart by blast the effect of which had reached the front of her thigh There was extensive hæmorrhage but the rectum and all main vessels and nerves had escaped injury The cause of death was shock.

Similar cases must be familiar to all surgeons who have dealt with air raid casualties they are usually fatal from the severe degree of shock from which they are suffering and little can be done to save them

GENERAL PRINCIPLES OF WOUND TREATMENT

Every wound, except those inflicted by the surgeon, is potentially infected As we have seen (p 120) a certain period elapses before invading organisms actually establish themselves become embedded in the tissues and start to multiply and form toxins How long does it last? and Can we utilise it to prevent infection and convert the wound into a clean surgical one? The answer to these two questions lays the foundations upon which the treatment of *all* wounds is built up

This safe period lasts for at least six probably eight, hours and in some cases for twelve it is accepted that up to eight hours from the receipt of injury surgical treatment should succeed in preventing all but superficial sepsis It will do so only if the following general principles be strictly adhered to

1 Every wound demands operation under full anæsthesia and full aseptic technique The former should require no comment but the latter so often is honoured more in the breach than the observance In civil surgery many minor injuries are dealt with in casualty departments of hospitals by an imperfect aseptic ritual in war asepsis is sometimes sacrificed to speed and casualties may be sent direct to the theatre imperfectly prepared, often indeed not fully undressed. There is hardly an emergency which can justify so flagrant a breach of surgical principles.

2 Protect the wound and cleanse the skin. The wounded area is protected by laying on it (not packing into it) sterile gauze which is maintained in position by hand. The surrounding skin over a wide area is rigorously cleansed with ether soap and warm water in air raid casualties in whom the skin was engrained with brick and mortar dust I used a sterile scrubbing brush. The area is then dried, shaved and painted with an antiseptic liquid (alcohol when available liquor anti septicus when not) The field of operation is then towelled up as in a clean operation and the surgeon and his assistant *rewash* and don sterile gowns and gloves The gauze is removed from the wound

3 Excise the wound edges Using a very fine knife and toothed

forceps the edge of both skin and subcutaneous tissue is removed in one piece It is quite unnecessary to take away more than ⅛ in. of these tissues

4 Explore and identify every lesion. The wound must be explored in its whole extent and this will frequently entail its extension by one or more suitably placed incisions. Then every lesion must be identified with meticulous care. This is the process of débridement which differs from simple excision in being more searching and thereby more efficient

5 Remove all seriously damaged tissue All dead and devitalised tissue especially muscle and fibrous material is an excellent pabulum for bacteria All such components of the wound must be cut away until a healthy bleeding surface is revealed. Fragments of bone still attached by shreds of fibrous tissue should be left *in situ* only small completely free bone chips need removal. Every particle of foreign substance *e.g* glass wood or metal splinters pieces of clothing etc must be removed

6 Obtain hæmostasis Buried ligatures are to be avoided as far as possible large vessels must be tied but smaller points can be controlled by crushing Our object is to leave the wound as dry as can be

7 Suture nerves and extrasynovial tendons (see Chaps XLIII and L)

8 Insufflate every recess and surface with sulphanilamide or penicillin powder (see p 203)

9 Drain the wound except in clean operation cases when the probability of collections of blood and serum can confidently be excluded. Rubber tubes should be avoided, except for certain special situations and soft rubber tissue used

10 Suture the wound *if this can be done without tension* This proviso is absolute and admits of no exception it is better to leave a wound open than to stitch it too tightly The latter impedes the blood supply and predisposes to infection This principle also applies to deeper layers *e.g* deep fascia fibrous septa in the limbs etc in which special incisions may be needed to prevent undue tension at this level Fig 50 shows different types of skin suture

11 Dress the wound A clean sutured incision requires a simple dry sterilised gauze dressing covered by a layer of wool. The whole is retained by a bandage firmly and evenly applied to support the parts When a tourniquet has been employed a Robert Jones pressure bandage should be used as for example after the removal of a semilunar cartilage from the knee A layer of gauze and wool is loosely fixed by a sterile bandage over which is laid a thick layer of wool from ankle to groin and this in turn is bandaged more firmly Finally another layer of wool is applied and the third bandage can be pulled tightly and evenly

The time during which dressings must be retained varies considerably In general we can say that bulky dressings are kept in place unnecessarily long Not only are they uncomfortable but both gauze and wool are expensive and scarce Clean surgical wounds are sealed within twenty four hours and need nothing more than a single

layer of gauze held in place by mastisol collodion or plaster strapping. Other wounds such as that following a radical mastectomy require large dressings and firm pressure while all discharging wounds obviously call for generous applications of absorptive material. Such dressings however should be changed as infrequently as possible and then only with those special precautions to prevent cross infection described on p 129

12 Immobilise the wounded area. Certain anatomical regions either cannot be put at rest (*e.g.*, the gastro-intestinal tract) or do

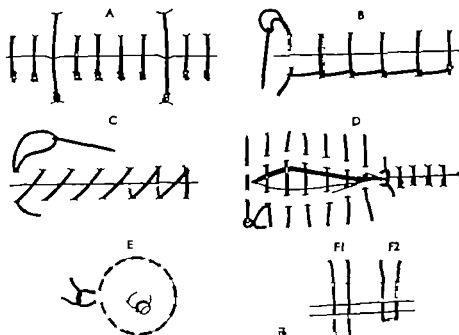


FIG. 50

Diagram of different types of sutures.

A, Interrupted coaptation sutures with two deep-tension sutures; B, a blanket stitch; C, a continuous skin stitch; D, a Lembert's invaginating stitch here shown as interrupted, but it can be used as a continuous suture also; E, a purse-string suture; F1, a mattress stitch; and F2, an overlapping or sliding stitch.

not require it. Wounds of the extremities especially those of war have been shown by Trueta and confirmed by all those who have dealt with air raid and battle casualties to progress more favourably when encased in plaster of Paris (see below)

13 General treatment involves attention to the patient's diet, bowel and bladder. In traumatic surgery pain will not be a prominent feature if the closed plaster technique has been adopted but after many surgical operations it may be severe and call for the administration of opiates for some days

Finally every patient sustaining a potentially infected wound must be given a prophylactic injection of both anti-tetanic and anti-gas gangrene serum (pp 34 and 38) as well as full doses of sulphadiazine and penicillin orally every four hours

MODIFICATION IN TECHNIQUE FOR INFECTED WOUNDS

We have seen that after eight, twelve or at most eighteen hours a wound is inevitably infected and its débridement ' as detailed above is no longer the method of choice in fact such a procedure would do more harm than good In these cases wounds must be en larged to ensure free drainage relieve tension and remove foreign bodies and all obviously dead tissue (Figs 51 and 52)

Closed Plaster Method.—The wound—after adequate surgical treatment—is lightly packed with vaseline gauze Although the original Winnett-Orr technique of applying plaster directly to the skin is followed by many surgeons, there is grave danger in such a pro cedure and it is our practice to protect the limb with a thin layer of vaseline gauze in the whole extent to be covered Plaster is then applied so as to immobilise the joints above and below the wound and to maintain them in their most favourably functional position When the plaster has firmly set the limb is elevated to 45 degrees to assist venous and lymphatic return. We believe that this small detail of technique is of great importance and one which does not receive the attention it deserves. The plaster is left on for three or four weeks

It is essential that the indications for the removal of the plaster be thoroughly understood. They are (1) presence of pain and swelling (2) looseness of the plaster from muscular wasting (3) a sudden sharp rise of temperature maintained for more than twelve hours (4) secondary hæmorrhage (5) evidence of gas gangrene and (6) smell. The last is inevitable but can be controlled for a time and to a certain extent by the use of deodorising bags

Carrel Dakin Treatment.—Continuous irrigation of wounds by eusol has been eclipsed by the closed plaster method Nevertheless it has its place in the treatment of heavily infected wounds with a tendency to deep pocketing and it is a perfect preparation for skin grafting or secondary suture in the final stages

Late Closure.—Provided effective chemotherapy is available there are to-day few wounds which cannot be closed by primary suture If however for mechanical reasons or because of obvious gross con tamination the wound was not closed after the first surgical inter vention the following methods may be used—all of which save much time and largely prevent subsequent deformities from contraction of scar tissue

A DELAYED PRIMARY SUTURE carried out within the first week should be employed when the wound has been left open for safety reasons in the first instance but the subsequent progress of the patient shows that danger no longer exists

B SECONDARY SUTURE —By the end of a week an *open* wound should be covered by granulation tissue Suture can now be carried out even in the presence of mild sepsis provided that retained foreign bodies have not led to the *formation of a sinus*

Exuberant granulations should be gently removed the skin edges undercut to an extent sufficient to allow their *eversion* and after powdering the area with penicillin the skin is brought together with a

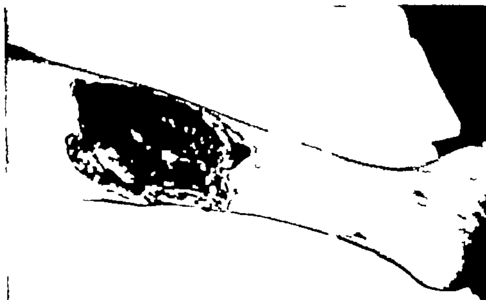


Fig 51

Private H. A. Admitted 1st June 1940, two days after being wounded. Showing the large ex wound, grossly infected. Treated by the closed plaster technique. (*Surgery of Modern Warfare.*)



Fig. 5_

Pri t H A The plaster as renewed on the 14th, 1st and 34th days. Showing the cle granulating ound on removal of the final plaster (*Surgery of Modern Warfare.*)

few mattress sutures interspersed with more superficial stitches A small wick of soft rubber tissue in one end of the wound is always a wise precaution and should be retained for forty-eight hours It must be understood that secondary suture should never be attempted if tension is needed to obtain close apposition of the skin edges

C SKIN GRAFTING —Where there has been such loss of tissue that apposition of the skin edges is impossible without tension the granulating area should be skin grafted as soon as possible by one of the methods described on p 100 Mild sepsis is no bar to successful grafting but in cases of severe infection pinch grafts are likely to give better results than a Thiersch

CROSS-INFECTION OF WOUNDS

The secondary infection of certain specific lesions with non specific pyogenic cocci has long been recognised as an unusually serious complication. We are taught for example that a tuberculous abscess must on no account be contaminated by skin cocci lest a persistent sinus or even amyloid disease result But it is not so generally appreciated that the prevention of secondary infection is of equal importance in every wound I have drawn attention for many years to the urgent necessity of excluding staphylococci from the drainage incision for a streptococcal tenosynovitis in the flexor sheaths of the hand The Medical Research Council have done great service in emphasising the urgency of this question in their memorandum upon Hospital Infection of Wounds.

Cross-infection may result from many factors among which the following are the most important —

1 Faulty technique in dressing wounds A dressing requires two persons, the actual dresser and his assistant The former is concerned solely with the removal of old materials toilet of the wound and reapplication of gauze wool and bandages the latter is in charge of the dressing trolley and hands by means of forceps sterile instruments lotion bowls dressings etc to his colleague Our hands can never be sterilised and sterile rubber gloves cannot be worn for ward work except in very special circumstances so that all manipulations must be done with forceps The hands must never touch the wound its surrounding skin, the inner dressing any tubing or waterproof covering or any sterile bowl lotion or material

Details of the packing and sterilisation of drums and the equipment of a dressing trolley vary greatly in different hospitals They should be so arranged that successive dressings can be done rapidly without imperilling the sterility of any of their components

2 Imperfect sterilisation of ward utensils All bowls kidney dishes and irrigation vessels are sterilised by boiling in the usual way but it is frequently forgotten that special baths for arms and legs as well as the ordinary ward bath are in equal need of sterilisation. Small hand baths can be boiled if a large enough steriliser is available All other baths demand disinfection by scrubbing them with a mixture of domestic cleaning powder and undiluted lysol

may rise to 120 per cent) a transference of sodium and chlorides from plasma to cells and of potassium from cells to plasma a rise in non protein nitrogen and a lowered CO_2 combining power

TOXÆMIC PHASE —In the majority of non fatal cases shock passes off the circulation recovers and general systemic complications are infrequent unless bacterial invasion occurs in the burned area Rarely however severe constitutional symptoms appear which have many points of resemblance to the crush syndrome " This phase is marked by pyrexia mental disturbances oliguria albuminuria, a fall in plasma protein, a rise in blood urea and occasionally jaundice Death is likely to follow upon the renal and hepatic damage The pathology of this condition is not known it is possibly due to the absorption by the blood of large quantities of autolytic products from the burned area

BACTERIAL INFECTION —The nature of the injury (in spite of the sterilising effect of heat) the circumstances of its infliction and the problems associated with both first aid and later surgical treatment make bacterial invasion almost inevitable fortunately however the presence of organisms does not necessarily have much effect upon either local or general symptoms Nevertheless secondary infection is to be regarded as a grave complication since septicæmia may easily follow when a large surface provides so extensive an area for absorption. Many organisms are found *S albus S aureus Streptococci B coli B subtilis B proteus* and *B pyocyaneus* While the others may delay wound healing hæmolytic streptococci are responsible for the more severe complications

CLINICAL PICTURE

Symptoms can be classified under five headings —

1 Primary shock
2. Secondary shock
3 Acute toxæmia
4 Bacterial invasion.
5 Healing

Of these acute toxæmia is seen in very few people but in spite of improved methods of treatment bacterial invasion remains comparatively frequent

Primary Shock is of immediate onset and short duration (under two hours) It is closely akin to the vasovagal syndrome Patients complain of cold thirst nausea but of little pain though the memory of the agony of the actual burning remains The forehead is cold and clammy face cyanosed or grey Pulse rate drops to about 60 blood pressure falls to 85/50 and the capillary hæmoglobin is 115 per cent This combination of slow pulse low pressure and hæmoconcentration clearly defines primary from secondary shock and calls urgently for resuscitation therapy

Two hours after injury this initial shock is passing off and the general condition improves The pulse rises to 90 blood pressure is up to 105/60 and hæmoglobin is 125 per cent

Secondary Shock.—This improvement is transient and within the next hour the patient is becoming restless and anxious So great is the thirst that it cannot be assuaged more especially as vomiting

occurs at each attempt at swallowing The face is grey cold and clammy pulse rate is mounting from 110 to 120 blood pressure is falling and still further hæmoconcentration follows If treatment is not available at this stage a fatal issue is inevitable

Under usual conditions however treatment will have prevented any severe degree of secondary shock and the clinical picture is different Resuscitation has been started in the period of primary shock and the general condition and blood pressure have returned so nearly to normal that local treatment of the burned area is undertaken During the twenty four hours that follow careful readings of pulse and blood pressure are recorded hourly and a decline will be observed on two or three occasions. Each fall will be controlled by plasma transfusion and by the end of twenty four to thirty-six hours the general condition of the patient will be stabilised and in many cases no further complication arises and a smooth if tedious convalescence lies ahead

Acute Toxæmia.—A small number of patients will suffer from toxæmia After thirty-six to forty-eight hours the temperature rises

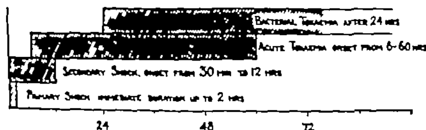


Fig 54

Schematic drawing showing the overlapping of the stages of shock and toxæmia.
(By kind permission of H.M. Stationery Office in Scotland from the E.M.S. Memorandum No. 6.)

to 102° or higher pulse is about 100 blood pressure 100/65 and hæmoglobin 90 per cent The patient becomes restless and mentally confused and vomiting occurs The urine output is scanty and blood urea rises sharply even to 200 mg If recovery ensues jaundice may appear but other toxic manifestations slowly disappear after seventy two hours

Bacterial Invasion may occur at any time but is apt to be most severe when the sloughs on deep burns are in process of separation. Toxæmia is usually of moderate intensity but its duration of one to four weeks leads to prostration emaciation and anæmia In a small number of patients septicæmia occurs and death ensues or a prolonged illness with metastatic collections of pus complicates an already grave condition.

Period of Healing—A time arrives when all sloughs have been shed and all deep areas are covered with healthy granulation tissue This turning of the corner is so abrupt and dramatic that the general condition alters within twenty four hours The patient sleeps profoundly eats voraciously puts on weight regains a normal blood picture and undergoes a complete mental change Healing goes steadily forward and although periods of sluggishness and stagnation occur epithelialisation is finally completed

Overlapping of the Phases.—The above description presents clear-cut

phases but these overlap so that it is not always quite obvious what the exact state of affairs is This is illustrated by the scheme on p 135 from the E M S Memorandum No 8 (Fig 54)

TREATMENT

General

A **On Reception.**—Immediately on arrival a burned patient is put to bed and swathed in blankets while a large radiant heat cradle is placed overall No attempt to remove the clothing or to assess the extent of the burn is permissible at this stage If morphia has not been administered before arrival an intramuscular injection of ¼ gr is given forthwith Pulse and blood pressure readings are taken at ten minute intervals to determine the type and degree of shock. Unless the patient s condition obviously demands resuscitation, no further interference is desirable for half an hour at the end of which warmth and morphia are taking effect At this stage a brief inspection is carried out to define the surface extent of the burn

B **Stage of Primary Shock** is treated by morphia heat and rest During this period our attention is directed towards the prevention of secondary shock if this is possible No local treatment of any sort is permissible until this has been done

C **Stage of Secondary Shock.**—Prevention and treatment of secondary shock are identical our study of pathology has taught us that the volume of the circulating blood and its plasma content must be restored as rapidly as possible For this reason transfusions of plasma are given whole blood and normal or glucose saline being equally contraindicated the former leading to increased hæmoconcentration and the latter to a serious depletion of plasma protein owing to increased capillary permeability

Suprarenal extracts such as cortin or similar synthetic compounds are powerful adjuvants to plasma transfusion, and oxygen inhalations through a B L B mask are helpful (p 162)

D **After Local Treatment.**—For twenty four hours repeated falls of blood pressure are apt to occur and regular pulse and pressure *readings will be taken every half hour to detect them Each will be* treated by plasma transfusions and during this period two or three will probably be needed or a continuous plasma drip can be set up

E **Stage of Toxæmia.**—Since its etiology is obscure the treatment of toxæmia is unsatisfactory There is some evidence that the incidence is less in cases treated by coagulation therapy Glucose should be given generously by mouth in order to prevent liver damage and cortin combats circulatory failure

Local

Our study of the pathology of burns suggests that our objects in treatment are to—

1 Cleanse the burned area and its surroundings and to prevent infection

2 Cover all exposed sensory nerve endings to reduce pain and shock
3 Seal all exuding surfaces to prevent external loss of plasma and
4 Provide ideal conditions for healing

Coagulation therapy fulfils all these requirements most admirably Its few disadvantages were given such undue prominence during the first year of this last war that there was a real danger of its falling into disrepute

A **Preparation.**—There is a certain similarity between a superficial burn and an open wound Both are potentially infected and just as the latter has a safe period of from eight to twelve hours so a burn can be saved from sepsis if treated within twenty four or at most thirty hours The prophylactic use of penicillin has contributed greatly to the prevention of sepsis at this stage

When shock has been controlled the patient is taken to the theatre and given a general anæsthetic gas-oxygen-ether being the method of choice All clothing is carefully removed and the patient transferred to the operating table Under no circumstances should large areas be exposed at a time but in extensive burns small sections should be dealt with in succession. Every blister is punctured and all detached epithelium removed by gentle swabbing with gauze and normal saline Rough handling and the use of a scrubbing brush are absolutely forbidden as are all irritating or dehydrating antiseptics

B **Coagulation.**—The burned area is now sprayed with 15 to 20 per cent solution of tannic acid or with 5 per cent tannic acid followed by 10 per cent silver nitrate This is continued until the surface turns brown Whilst this spraying is in progress the whole area is being dried by a stream of hot air from an electric hair drier to the outlet of which a filter must be fitted to trap organisms which would otherwise be driven on to the burn in large numbers When the operation is completed all burned areas are covered with sterile towels and the patient returned to the ward If the position and extent of the damage permit the whole surface is exposed to radiant heat beneath a special cradle and no clothes or dressings are allowed to touch it Drying is continued for twenty four hours after which the pellicle has turned black (Fig 55) is firm and securely adherent to underlying tissues Attention is directed to preserving it from cracking anticipating any premature separation and to the recognition of sepsis below it at the earliest moment Any fresh blisters which form at or near the periphery are pricked and tanned as are all fissures Eventually the pellicle will separate normally after epithelium has grown in beneath it this process being a perfect example of the classical "healing beneath a scab"

In extensive burns it is impossible to protect every part from pressure Patients should lie upon the least damaged area which is coagulated and then protected by a gauze dressing in some cases it may be preferable to use a tannic acid jelly from the outset for these areas

C **Penicillin Cream.**—More recently penicillin cream has been used in preference to other methods, and some surgeons believe it to give better results than coagulation. This method has the disadvantage of needing repeated dressings.

This treatment is in special favour for burns of the face and hands in which coagulation therapy is contraindicated (see below.)

D **Deep Burns.**—The difficulty of assessing accurately the depth has been stressed above. For this reason the whole area is coagulated although theoretically a deep burn has already provided its own protective coagulum since the skin has undergone coagulation necrosis.



FIG. 53

The appearance of an extensive burn of the back after the application of tannic acid

Coagulation however ensures that all surface lesions are adequately protected and all areas of exudation are sealed. After a long period the dead skin separates and finally healing may be accelerated by skin grafting.

E **Established Sepsis.**—If more than thirty-six hours have elapsed since injury before the patient reaches hospital, the burned areas are infected and coagulation therapy is no longer safe. Again apparently clean burns may become grossly septic beneath a pellicle which will be rapidly cast off as a result. Such septic burns require different treatment and many methods are available, but irrigation in conjunction with a Stannard envelope is most satisfactory for the limbs; on the trunk, head and neck other means must be used.

The Stannard envelope is made of waterproofed silk and is designed in various shapes and sizes for the upper and lower limbs (Fig. 56). Its upper end is sealed to the skin by adhesive strapping and the burned area is completely exposed within it. Irrigation is carried out with 1: 20 Milton (electrolytic sodium hypochlorite) at 100° F for twenty minutes three times a day. After each treatment the contents are drained away and the envelope filled with oxygen and both

inlet and outlet tubes securely clamped Results have been excellent and this method is a valuable addition to burn treatment

Saline packs are useful for septic burns of the trunk The damaged area is covered with tulle gras and thick pads of gauze soaked in normal saline They must never be allowed to become dry either they must be changed every two hours or some method of drip feed installed to maintain their moisture

Oily dressings such as cod liver oil emulsion and glycerin sulphapyridine paste are useful in deep burns and in encouraging granulating areas to heal or to prepare them for grafting

F **Late Skin Grafting**.—Superficial burns heal by the re-formation of squamous epithelium from the remnants of corium which have survived Deep burns in due course will present a granulating surface



FIG 56

The envelope method of treating burns. Note the entrance and exit diverticula for irrigations. (*Surgery of Modern Warfare.*)

Skin grafting accelerates healing and assists in the prevention of contraction deformities

BURNS IN SPECIAL SITES

Burns of the Fingers and Hand present special problems A coagulum contracts on drying and when surrounding a finger completely is liable to constrict its digital vessels and so imperil its nutrition. Further on the dorsal aspect of the hand the skin is thin subcutaneous fat is absent and tendons joint capsules and bones are highly vulnerable Contractures will occur unless special attention is directed to position in treatment and re-education afterwards

In no other part of the body are burns of such great importance in relation to function It is claimed that in non fatal cases a patient s usefulness in life is dependent entirely upon his hands no matter how severe the burns were elsewhere Particular attention therefore must be paid to the avoidance of secondary infection the control of œdema and the prevention of webbing of the fingers by the individual dressing of each finger

The dangers of coagulation are possibly overrated but it is wise to forbid this method in this situation Less severe burns are best treated with triple dye while others respond most satisfactorily to irrigation with a Stannard envelope If dressings are applied the hand must be placed in the position of function (Fig 57)



FIG. 57
The position of function

Burns of the Face demand special notice because of the likelihood of unsightly scars and contractures affecting the eyelids lips, ears and nose Sepsis is apt to give trouble especially if the burn has extended into the hairy scalp Superficial burns which do not involve the eyelids lips or ears may safely be coagulated but it is essential that the scalp be shaved for at least 2 in beyond the limit of the burned area Some authorities prefer triple dye to tannic acid even in these safe areas Burns of the eyelids, lips and ears are best dealt with by penicillin cream

Deep burns may also be coagulated but it is important that they should be rid of their pellicle or slough within four weeks and the exposed surface immediately prepared for grafting It is better to anticipate contractures and scarring as far as possible than to be faced with extensive plastic operations later

Burns of the Eyeball are treated with liquid paraffin drops as an immediate first-aid measure and later attention is directed to the prevention of injury to the cornea and to adhesions between the globe and eyelids

FROST BITE

Frost bite is actually a localised form of gangrene and may be produced either by direct action of cold leading to vasospasm or to the effects of too rapid thawing when excessive exudation causes obliteration of the vascular supply of the part The most exposed and most distal parts are naturally those usually affected (nose ears, fingers and toes) and children and the aged are the worst sufferers. The direct cold type is a dry painless gangrene affecting a larger area on the surface than in the deeper tissues The part becomes white and waxy and shrivels up then later turns black and is separated and cast off

In the congestive type there is a great deal of pain and inflammation followed often by vascular thrombosis Recovery may occur without loss of tissue but superficial ulcers are usual

Treatment is prophylactic being the avoidance of or protection against exposure and the slow and careful thawing of a frost bitten part If gangrene occurs the part is kept dry until a satisfactory line of separation develops

TRENCH FOOT

Trench foot follows prolonged exposure to cold and wet occurring especially in those who have had to stand immobile for long periods It is exaggerated by tight boots and small or shrunken socks

The condition is due to peripheral vasoconstriction both direct and reflex in origin The resultant local ischæmia and anoxæmia tend to cellular damage in both vessels and nerves The consequent increased permeability of the smaller vessels leads to œdema and further pressure effects

Two clinical stages are described—ischæmic and hyperæmic In the former the foot is waxy white with mottled patches, a feeling of weight and numbness, and the gait is unsteady Peripheral pulses are absent and a patchy anæsthesia can be elicited In the latter return of pulsation, the presence of swelling blebs and ecchymoses and paræsthesia and pain are outstanding features

Treatment is essentially prophylactic by ensuring cleanliness drying of the feet night and morning the application of talcum powder and a change of warm and roomy socks twice daily The established condition is dealt with by very gentle warming of the limb avoidance of trauma and the strict maintenance of asepsis

ELECTRICAL INJURIES

These conditions include lightning stroke electrical burns and injuries from X rays and radium

If lightning stroke is not immediately fatal its effects are similar to those of severe electrical shock. In lightning shock it often happens that without any external signs on the surface of the body the clothes have been torn off bones broken and viscera ruptured External markings, when present are usually where some piece of metal, *e.g* a stud was in contact with the skin and are often arborescent in character

The severity of electrical burns varies not so much with the voltage as with the amperage Alternating currents are more dangerous than constant and length of contact is an important factor Some tissues conduct electricity better than others *e.g* cerebrospinal fluid blood and the viscera Pregnant women sleepers and those actively expecting a shock are less susceptible to the effects

The symptoms are (1) pain which is agonising and generalised and is often accompanied by such sensory changes as blindness deafness and hallucinations (2) all sense of time is lost and the patient feels as though the body had shrunk (3) unconsciousness usually follows associated later with some degree of retrograde amnesia (4) burns which are characterised by their unexpected depth in comparison to their surface extent by the friability of the vessels in the neighbourhood by their tendency to spread and by their very tardy healing

Secondary effects include reactionary hæmorrhage falling out or blanching of the hair longitudinal fractures of bone œdema optic atrophy and cataract and both organic and functional changes in the

nervous system The cause of death is a combination of respirato. failure from inhibition of the medullary centres, and cardiac failur from ventricular fibrillation.

Treatment comprises removal of the patient from the source of th shock, immediate and prolonged artificial respiration, and genera measures as for a serious head injury Lumbar puncture is said t be particularly efficacious. Opinions vary as to the treatment of th burn, some surgeons advising conservative treatment others radica excision and grafting

RADIUM AND X RAY BURNS

These result from over-exposure during therapy It must b realised that to obtain a maximum therapeutic effect the radiologi must produce a mild burn, such a full dose being known an referred to as an *erythema* dose After the redness has died away the skin may become dry hard and itchy and surface desquamatio ensue Hair is lost and the nails become brittle Some degree o pigmentation may persist and the condition tends to relapse. Suc an X-ray dermatitis may progress until it assumes the character of a low-grade squamous-celled carcinoma Various tissues reac differently to X-rays the scalp being very resistant while the normall moist areas (axillæ groins vulva etc) are peculiarly sensitive

Longer and more intense exposure to both X rays and radium produces a definite tissue necrosis These ulcers are very painful an form large sloughs which are slow to separate and slower still to heal.

Treatment consists in complete excision if possible otherwis diathermy ultra violet light or short wave therapy may assist in th separation of the slough and the healing of the wound Graftin should be done as soon as the state of the wound permits

CHEMICAL INJURIES

Strong caustics and corrosives particularly acids produce localise necrosis if they come in contact with the skin. The degree of tissu destruction depends on the strength of the solution and the length o application. Such burns are characterised by considerable pain excessive slough formation and slow healing followed by marked contraction of the scar Treatment consists in the application o antiseptic dressings and prevention of contraction by splints and ski grafting

R M. HANDFIELD-JONES.

CHAPTER VIII

HÆMORRHAGE AND SHOCK

HÆMORRHAGE

THE term hæmorrhage implies a loss of blood from the vessels and in that there are three types of blood vessels so hæmorrhage is classified as being arterial venous and capillary Hæmorrhage is usually due to trauma but it may also be the outcome of certain constitutional diseases either congenital in origin such as hæmophilia or acquired as in purpura leukæmia and scurvy or be secondary to pathological changes occurring in the vessel walls *e.g* aneurysm or atheroma

Any of the three types of hæmorrhage may be further subdivided into external and internal

External Hæmorrhage may occur from the skin as the result of wounds, or from one of the natural orifices of the body In this respect certain terms are in common use *epistaxis* (blood from the nose) *hæmoptysis* (blood coughed up from the lungs or respiratory passages) *hæmatemesis* (blood vomited up from the stomach) *melæna* (blood passed per rectum) and *hæmaturia* (blood voided in the urine)

The blood in epistaxis is bright red as is that of hæmoptysis having been recently oxygenated This recent admixture with air also accounts for its being frothy The blood in hæmatemesis may have been swallowed from the nasopharynx before being vomited Its colour depends on the time it has been in contact with gastric secretions prolonged action of which produces dark brown clotted fragments—the coffee grounds vomit In hæmaturia the colour depends on the site of the bleeding and its rapidity In melæna the blood has been altered by the intestinal secretions so that the stools are coloured black but bleeding occurring low in the rectum is bright red

Internal Hæmorrhage may be of two varieties the subcutaneous, which is more or less obvious and the deep or concealed which occurs in the deeper tissues organs or cavities of the body In both groups there are several terms which must be defined. *Extravasation* of blood implies an escape into the submucous subcutaneous or subserous tissues almost synonymous is the term *ecchymosis* although in this case the blood has usually worked towards the surface from the deeper planes The end result in both these types is called a *bruise*. If the blood poured out is limited by tissue planes and is in any quantity the resultant collection is known as a *hæmatoma* whilst small multiple extravasations beneath the skin or other lining membrane are termed *petechiæ*

Concealed hæmorrhage occurring into the pleural cavity is called *hæmothorax* into the peritoneum *hæmoperitoneum* into the tunica vaginalis of the testis *hæmatocele* into a joint *hæmarthrosis* into the fallopian tubes uterus and vagina, *hæmatosalpinx hæmatometra* and *hæmatocolpos* respectively and into the spinal cord *hæmatorrhachis* if extradural and *hæmatomyelia* if intramedullary To bleeding into the substance of the brain the term *apoplexy* is often applied These conditions are fully described in the chapters concerned

THE CLINICAL PICTURE OF HÆMORRHAGE

Local.—The signs of external hæmorrhage are obvious and will be referred to in detail in the description of the three main types of bleeding (see p 154)

In internal hæmorrhage local signs are absent but the history and general symptoms combined with signs of fluid in an internal cavity will assist diagnosis In this respect it must be noted that the quantity of blood poured out will affect the length of time it remains fluid. In small extravasations as for example into the tunica vaginalis fluctuation may be obtained in the early stages and this combined with an absence of transillumination, would strongly suggest a hæmorrhage Fluid in the pleura and peritoneum may be recognised by certain clinical signs but in general it will be seen that these signs are simply those of an effusion which can be identified as blood only if the general clinical picture suggests this possibility

General.—Constitutional effects naturally vary with the amount of blood lost and the rapidity with which it is shed. If half the total volume is lost in a very short time the result is fatal whereas a gradual loss of 60 per cent is still compatible with life. In infants and the aged the effects of hæmorrhage are more marked but in the former recovery is very rapid as a general rule women suffer less severely from considerable loss of blood than men and in pregnancy their powers of recovery are remarkable The presence of certain accessory factors render the effects of hæmorrhage more serious In anæmia the vital hæmoglobin content is already low shock, which so often accompanies bleeding is responsible for a continued depression of blood pressure which prevents the usual post hæmorrhagic revitalising rise jaundice due to the presence of bile salts leads to a diminution in the normal clotting power of the blood while sepsis septicæmia, hæmophilia, scurvy and purpura are all examples of diseases in which a small hæmorrhage may have very serious results.

Massive hæmorrhage may lead to death in a few minutes from syncope In non fatal cases two factors are responsible for the general symptoms viz loss of body fluid (dehydration) and loss of hæmoglobin (the oxygen-carrier) Dehydration in the normal course of events is rapidly made good by replacement with tissue lymph but red blood corpuscles are regenerated slowly Cerebral anæmia may result in unconsciousness usually temporary (a fainting attack) but subsequent effort may cause a repetition The patient is very pale cold and clammy the red margin of the lips the nail beds and the inner

lining of the lower eyelids being the tissues to give the earliest and most valuable indication of loss of blood The pulse is rapid feeble and irregular and the systolic blood pressure falls rapidly but should soon start to recover after the bleeding has ceased owing to reflex peripheral vasoconstriction and to the influx of tissue fluids into the blood stream Respiration is rapid and shallow with long gasping sighs at intervals as the patient strives to obtain more oxygen This is described as *air hunger* and is accompanied by marked restlessness Great thirst is complained of as are tinnitus or even deafness flashes of light or dim vision and severe headache from cerebral anæmia. The temperature is subnormal

Natural Arrest of Hæmorrhage.—It is well known that many minor hæmorrhages and not a few major ones will stop spontaneously The essential factor in bringing this about is the coagulability of the blood Clot *is formed of fibrin which in the early temporary stages of arrest is* soft and jelly-like and contains many red blood corpuscles This red clot" is formed both within and outside the damaged vessel *i.e* internal and external clots The fibrin is produced by the action of thrombin on the fibrinogen of the circulating blood and this thrombin is the result of interaction between the calcium salts of the blood with a substance called prothrombin Whether prothrombin action results from its activation by the thrombokinase freed from damaged cells or from neutralisation of a normally present antithrombin by a substance named thromboplastin is not yet definitely decided.

Subsidiary factors which influence the formation of a clot are retraction of the intima and contraction of the media The absence of this factor in partial wounds of vessels or in incised as against lacerated wounds accounts for the more prolonged hæmorrhage met ith in the former case If hæmorrhage is considerable a fall of blood essure occurs and anæmia of the medullary cardiac centre leads to minution in force of the heart beat This produces a slow blood ream and an increased viscosity whilst finally the compensatory ck flow of tissue fluid into the vessels to replace the blood loss ings with it copious supplies of fibrinogen

The red clot formed by this combination of factors soon becomes filtrated with platelets and white corpuscles and it is this white clot" hich is organised by simple plastic inflammation in a similar manner to n inflammatory exudate so producing permanent arrest of hæmorrhage y fibrosis

GENERAL TREATMENT

General treatment consists essentially in arrest of the bleeding but any patients after a severe hæmorrhage are too ill to withstand any rgical measures The methods of general treatment will therefore be escribed first

Complete rest and quiet are the first essentials in every major æmorrhage The head should be kept low to ensure that the vital edullary centres get as great a share as possible of what blood there is his may be achieved by removing all pillows raising the foot of the ed on blocks *and in very severe cases by bandaging the limbs*

firmly from the periphery towards the trunk. Patients must lie as quiet and motionless as possible warmth supplied by a radiant heat cradle or by carefully placed hot water bottles is a great advantage if used with discretion Overheating defeats its own ends by producing cutaneous vasodilatation leading to loss of urgently needed fluid by sweating Our real object is to maintain a normal body temperature Certain drugs are of value Morphia ensures that rest which is essential to the recovery of vitality and to the arrest of the hæmorrhage by clot formation To increase the coagulability of the blood calcium lactate may be given either intravenously (gr v of a 10 per cent solution) or rectally (in gr xv doses) and 25 c c of horse-serum or 2 c c of hæmoplastin given intramuscularly serve the same purpose. The general vasoconstrictors adrenalin (♏v of a 1 1000 solution of adrenalin chloride) or pituitrin (1 c c.) subcutaneously will help to stop bleeding, but as they also raise the blood pressure they may neutralise their own good effects Stimulants such as strychnine have the same disadvantage but may perforce have to be given in cases of syncope

The remaining methods of general treatment involve the replacement of either the fluid content of the blood or of blood itself The latter is obviously the method of choice but certain technical difficulties and certain possible sequelæ make it applicable only under favourable conditions

INFUSION may be intravenous rectal (proctoclysis) intramuscular or intradermal (hypodermoclysis) In intravenous infusion the most rapid method some relatively superficial vein (the median basilic or cephalic at the elbow the internal saphenous at the ankle and the superior longitudinal sinus in infants) is selected, and if sufficiently obvious is pierced by a medium bore needle subcutaneously If the vein is impalpable, a transverse incision is made over its course and the vessel exposed It is then tied distally and a glass or metal cannula inserted proximal to the ligature through an oblique slit in the vein wall (Fig 58) Leakage is prevented by a second ligature tied tightly round the cannula and when the infusion is completed the cannula is withdrawn and the ligature tied Whether a needle or cannula be used it is important to see that it is full of fluid before insertion to avoid the introduction of air bubbles into the circulation The danger of air embolism, however from the injection of small bubbles of air into a peripheral limb vein is probably very slight The fluid used is usually normal saline (ʒi of sodium chloride to 1 pint of sterile water) though a 6 per cent solution of gum acacia in saline is thought to have more lasting effects The fluid should be warmed to 110 F Two or 3 pints can be given rapidly at first but later an apparatus providing a continuous drip is to be preferred (Fig 59)

Absorption of fluid from the bowel after rectal infusion varies considerably with the individual and with the contents of the bowel. Ten pints of saline or water can be given in twenty four hours by this route a continuous-drip apparatus (*e.g* Murphy's) being used. Absorption is not so satisfactory when a large quantity is run into the rectum rapidly

In cases of great urgency and if the operator is single-handed, a needle may be introduced beneath the skin into the loose connective tissue of the submammary region buttock thigh or abdominal wall and connected to a receiver (about 5 ft above the patient) containing normal saline This will provide a steady if somewhat slow absorption of fluid Excessive subcutaneous tension and a fluid temperature above 110 F must be avoided or sloughing will occur at the site of infusion Absorption is safer and more certain if saline is introduced into large muscles

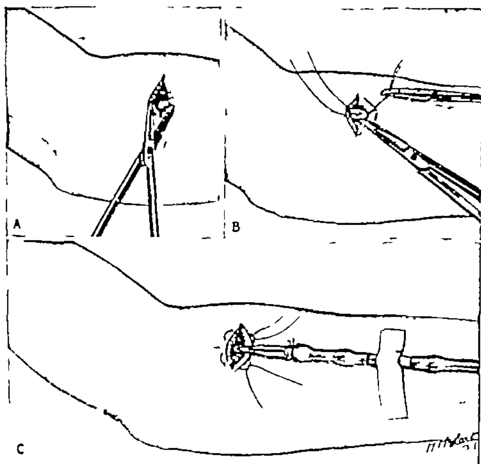


FIG 58

Drawing to show the method of exposing the vein and of tying in the cannula. (*Farquharson.*)

Blood Transfusion

The first essential is to find a prospective donor whose blood is safely miscible with that of the patient Blood contains bodies known as agglutinins and hæmolysins and in incompatible bloods the donor's red cells may become agglutinated by these substances in the recipient's serum This agglutination may be but is not necessarily followed by a breaking up of the donor's corpuscles i.e. hæmolysis It is necessary therefore before transfusions to test the donor's corpuscles against

firmly from the periphery towards the trunk Patients must lie a quiet and motionless as possible warmth supplied by a radiant heat cradle or by carefully placed hot-water bottles is a great advantage if used with discretion. Overheating defeats its own ends by producing cutaneous vasodilatation leading to loss of urgently needed fluid by sweating Our real object is to maintain a normal body temperature Certain drugs are of value Morphia ensures that rest which is *essential to the recovery of vitality and to the arrest of the* hæmorrhage by clot formation. To increase the coagulability of the blood, calcium lactate may be given either intravenously (gr v of a 10 per cent solution) or rectally (in gr xv doses) and 25 c c of horse serum or 2 c c. of hæmoplastin given intramuscularly serve the same purpose The general vasoconstrictors, adrenalin (♏v of a 1 1000 solution of adrenalin chloride) or pituitrin (1 c c) subcutaneously will help to stop bleeding, but as they also raise the blood pressure they may neutralise their own good effects Stimulants, such as strychnine have the same disadvantage but may perforce have to be given in cases of syncope

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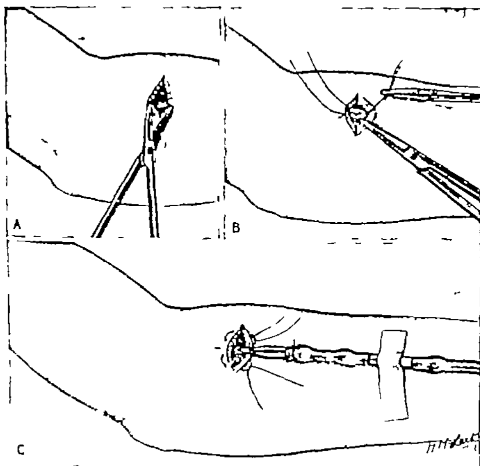


FIG. 48

Drawing to show the method of exposing the vein and of tying in the cannula. (Farquharson.)

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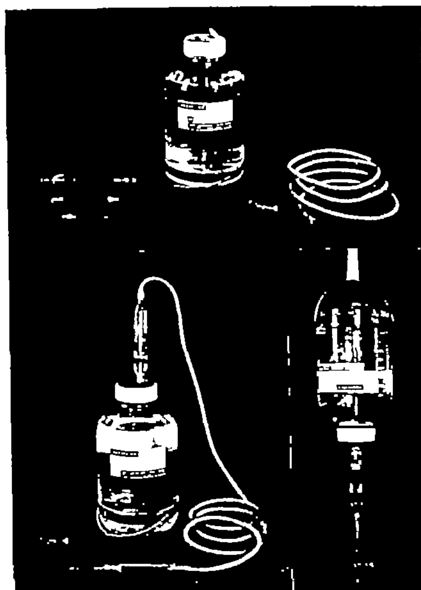


FIG. 59

"Vasolitre" saline infusion apparatus and method of use. (*Farquharson.*)

A, 1000-c.c. flask with delivery apparatus, consisting of dropping tube, 6 ft. of rubber tubing and clip, glass connection and intravenous needle.

B, The metal cap is removed and the rubber diaphragm cut away. The dropping tube, which has been connected to the rest of the delivery apparatus, is plugged into one of the two holes in the rubber bung, indicated by an arrow. The other hole carries a glass air inlet tube already fixed in position.

C, The flask is inverted and suspended by the handle, ready for use.

the recipient s plasma The reverse is of small importance because of the very rapid dilution of the donor s plasma once it gets into the recipient s circulation

Human beings fall into four blood groups. In the past there have been various methods of group nomenclature but to-day the Landsteiner classification finds universal acceptance The following table gives the reactions of the various groups and their percentage occurrence —

Donor's Cells.	Recipient s Serum.				Percentage Occurrence.
	Group AB	Group A.	Group B.	Group O	
Group AB	−	+	+	+	5 per cent.
Group A	−	−	+	+	40 "
Group B	−	+	−	+	10 "
Group O	−	−	−	−	45 "

+ = Agglutination. − = Non-agglutination.

It will be seen that a Group AB serum can receive blood from any donor (universal recipients) whilst a Group O donor can give to any other group without agglutination (universal donors) In most cities to-day and in many hospitals there are efficient transfusion services by which potential donors of known group tested blood and robust health are made available as required But even when a donor of known group can be supplied compatibility tests between donor and recipient should be carried out before transfusion except in most dire emergencies In such cases a universal donor should be used, except for repeated transfusions or in the case of a late pregnancy or the puerperium

Group Tests.—Specific tests of donor against recipient can be carried out by direct or indirect methods In the indirect technique the corpuscles of donor and recipient are tested separately by obtaining a drop of blood (from the lobe of the ear or the finger) This is mixed with a drop of fresh stock test sera of Groups A and B bloods the appended table showing the possible results —

	Corpuscles.			
	AB	A.	B.	O
Serum A	+	−	+	−
Serum B	+	+	−	−

+ = Agglutination. − = Non agglutination.

If the diluted blood is mixed with the stock serum on a glass slide or white tile agglutination can be readily observed by the appearance of fine dark sand in the drop This usually occurs in a few minutes but delayed agglutination up to half an hour or even longer is one cause of false grouping

In the direct method a few cubic centimetres of the recipient's blood are withdrawn from a vein, placed in a test tube and allowed to clot. *A drop of the resultant serum is then mixed with a drop of* the potential donor's blood and agglutination looked for

Effects of Incompatible Transfusion.—Administration of a grossly incompatible blood *i.e.*, of a wrong group produces agglutination and lysis of the red cells of the donor's blood. This grave—and easily avoidable—error leads to disaster In a number of patients death follows within an hour or in the course of a few days others survive after a serious illness. The first symptom occurs while the transfusion is in its earliest stages the patient complaining of severe pain in the kidney area of both loins. Should this occur transfusion must immediately be stopped A rigor difficulty in breathing and circulatory failure follow rapidly and later hæmoglobinuria jaundice urticaria and symptoms due to small emboli in the brain, heart muscle and gastro-intestinal tract make their appearance Should the patient survive this initial hæmolytic shock, a period of renal failure has to be overcome before convalescence is achieved.

Unpleasant reactions and even tragedies may occur however in cases of correct grouping, but in the absence of direct matching of recipient and donor These complications are practically unknown in single transfusions except late in pregnancy but multiple transfusions for such conditions as severe war wounds always carry this risk. We must understand why these phenomena happen.

SUBGROUPS A_1 AND A_2.—Groups AB and A are subdivisible into subgroups A_1 A_2, A_1B and A_2B with the result that in rare instances specific agglutinins α_1 and α_2 are formed in considerable amount The importance of these subgroups will be understood when it is realised that the agglutinins thus produced not only affect their opposites in their own groups but are also anti O th[e] universal donor

FACTORS M N AND P —*These inherited factors are of no practica[l]* significance in intragroup incompatibility only four cases having so fa[r] been recorded.

RHESUS FACTOR. —Recently the Rhesus factor has been shown t[o] be present in 85 per cent of human bloods The remaining 15 per cent Rh— contain no antibodies As a result from repeated transfusions *or from a fœtus in utero these people may develop the corresponding* agglutinin As Whitby points out the detection of the Rh facto[r] requires special technique, but for repeated transfusions and for pregnant women Rh— donors must be used. It is probable that this factor i[s] responsible for the great majority of hæmolytic reactions in homologous Landsteiner group transfusions especially after using a Group O donor

COLD AGGLUTININS are occasionally the source of great confusion and difficulties both in group testing and treatment Cold agglutinin is active only at or below 30° C Whitby reports cases in which a patient is said to be Group AB whereas on direct matching he appears to be incompatible even with a universal donor This nuisance can be overcome by testing and transfusing at 37° C

Methods of Transfusion.—Whatsoever method is used one thing is imperative The first 20 c c. must be injected very slowly and the transfusion abandoned immediately if severe pain in the back is produced. This constitutes the biological test and must never be omitted.

Kimpton s paraffined tube has been entirely discarded as has direct vein to vein connection The most common method is that in which the blood taken from the donor is either citrated or defibrinated and infused into the recipient at leisure Defibrinated blood obtained by continually shaking the blood round a glass rod in the collecting bottle is said to give fewer unpleasant after-effects than citrated blood In this latter method the donor s blood is run into a bottle containing 150 c.c. of sodium citrate solution (2 grm to 100 c c of distilled water) to the pint (approximately 568 c c.) of blood Blood is obtained from

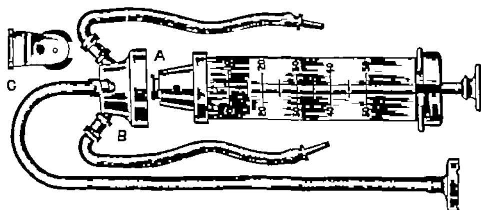


FIG. 60

The Rotanda three-way syringe. (*Allen & Hanburys.*)

A B and C are the component parts of the nozzle head with its three-channel distribution.

the donor by puncturing a vein with a wide-bore needle to which is attached a short length of rubber tubing leading into the collecting bottle which is immersed in hot water and gently rotated during the operation If a vein in the arm is used, a *sphygmomanometer cuff* is placed on the arm above and the pressure regulated to ensure a steady flow of blood

The blood is introduced into the recipient either by the force of gravity blood passing from a glass bottle through rubber tubing to the needle or cannula or by some type of syringe The three-way Rotanda syringe (Fig 60) has been found most serviceable one lead being connected to a flask of warm saline with which the whole circuit is first filled, another to the blood container and the third to the patient The blood should be given slowly at least twenty minutes being taken in giving 1 pint A modification of the greatest value is the continuous-drip method of transfusion (Fig 61) by which large quantities of blood can be given over a long period of time thereby overcoming all the disadvantages of the rapid transfusion The method entails apparatus

for keeping the blood warm and constantly mixed, and this is done by allowing oxygen to bubble through it

In infants the superior longitudinal sinus is usually used as the portal of entry and the amount given is 15 c.c per pound weight As an alternative the internal saphenous vein at the ankle is used in children.

Stored Blood.—The great demand for large quantities of blood which occurs when many casualties have to be dealt with in a short time presents a considerable problem to a transfusion service To meet this blood banks have been formed in which large quantities of citrated blood are stored for immediate use. Care is needed in collection sterilisation and group labelling but this method has proved a success during aerial bombardment of cities and it allows the trans portation of blood from central stores to distant battle areas by aeroplane Reactions are apparently little more frequent than with fresh blood but doubt persists as to how long it is safe to keep blood in store Except in periods of great pressure blood older than fourteen days should not be used

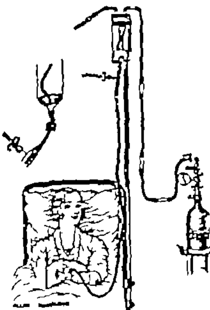


FIG. 61

Kekwick apparatus for the continu ous-drip administration of a blood or saline transfusion. (*Allen & Hanbury*.)

Plasma Transfusion.—For many purposes blood plasma has been found to be an excellent substitute for blood and in certain conditions, *e.g* burns it is superior It can be stored in its fluid state or dried and subsequently reconstituted It must however be emphasised that plasma transfusions carry a definite risk peculiar to this method. Delayed hepatitis with jaundice occurs in a number of patients who have had plasma transfusions It makes its appearance about twelve weeks after the original transfusions and, although the percentage affected is not high it has an exceedingly grave prognosis death occurring in over 00 per cent of patients.

Indications for Blood and Plasma Transfusions.—The great thera peutic value of each is likely to be lessened if they are regarded—a too prevalent belief—as equal and interchangeable in all conditions. Blood is obviously required when blood has been lost or destroyed by disease but its use in cases of non hæmorrhagic shock *e.g* burns may have a most damaging effect Plasma has a definite value in severe hæmorrhage but its chief use is in those conditions in which the body is suffering from fluid loss and its resultant hæmoconcentration.

The late general treatment of hæmorrhage includes the use of iron tonics, sunlight, fresh air plentiful nourishing diet and regulated rest

LOCAL TREATMENT

The aim of local treatment is to occlude the bleeding vessel until such time as natural arrest can take place The following methods are available —

1 **Pressure** as a temporary and an emergency measure either at the site of bleeding (particularly applicable to venous hæmorrhage) or over the main vessel of supply at some distance is invaluable when feasible Pressure can be exerted by the fingers by a pad firmly bandaged on or by a tourniquet of which there are many types In general compression should not be continued for periods over an hour in duration

2 **Position.**—In bleeding from a limb vessel elevation will assist hæmostasis the consequent emptying of the veins leading to a reflex arterial vasoconstriction

3 **Heat** may be applied in the form of very hot water (150 F) which causes constriction of the vessels by stimulation of its medial coat or by the cautery used at dull red heat or by diathermy These methods are applicable to bleeding from a large area, particularly if septic or from a cavity

4 **Cold** applied either as ice or very cold water acts in a similar manner It finds its chief application in oozing from the mouth, pharynx or even the stomach.

5 **Chemicals.**—Those used locally are divided into two main classes viz styptics and astringents The former cause direct coagulation the latter a mild type of vasoconstriction Of the styptics which are only of value in small wounds perchloride of iron alum, silver nitrate tannic and gallic acids and creosote are in common use The most popular astringents are turpentine hamamelis and lead acetate

Two other agents are worthy of mention Adrenalin (1 1000) applied locally will stop oozing and small free muscle grafts probably owing to their prothrombin content have a special field of usefulness in minor hæmorrhage from the surface of the brain the lung the liver and elsewhere

6 **Acupressure** is a method of historic interest A straight rod was inserted beneath the vessel and a figure-of-eight knot was tied over both vessel and rod.

7 **Forcipressure.**—The artery forceps of Spencer Wells and Kocher may be used to stop hæmorrhage from small vessels by causing adhesion of the intima from crushing the subsequent curling up of the intima and media allowing natural clotting to occur They are also used universally as a temporary hæmostatic until the bleeding vessel can be ligatured (*Fig* 62)

8 **Clamps** are simply forceps of special design and are used for big vessels or vascular pedicles (*e.g* the renal) They can be used as crushing instruments as a preliminary to ligation or can be left on for forty-eight hours to allow a natural clot to form behind them.

9 **Torsion.**—Small vessels particularly of the skin may be twisted

TRAUMATIC SHOCK

The Second World War provided material under ideal conditions for a vast amount of research into the pathology and treatment of shock. Looking over the stricken field we cannot but feel that this research had much the same effect upon this subject as had aerial bombardment upon the bricks and mortar of our cities It destroyed most of the old theories but put few solid concrete facts in their place

It has seemed to us that much of the confusion has arisen from an inexact and misapplied nomenclature The term "shock" is used to cover the state resulting from such diverse etiological factors as grave injury internal and external hæmorrhage burns perforation of abdominal viscera, biliary intestinal and renal colics a blow upon the solar plexus and even the receipt of bad news or injury to our moral susceptibilities. It is hardly surprising that chaos has resulted It seems desirable therefore that in all cases the word shock should be preceded by a definitive adjective to avoid all misconception. Accordingly we are about to describe Traumatic Shock.

Its Varieties.—It has been the accepted custom to divide shock into two types viz., primary and secondary since their etiology and clinical picture differ in many respects Their differentiation is not always easy and, moreover they are apt to merge indefinably the one into the other Indeed there is a tendency to-day to abandon altogether the term "primary shock. Nevertheless although the distinction is not entirely satisfactory the full clinical picture and treatment of shock cannot be understood unless this classification is retained.

PRIMARY SHOCK

Primary shock is a condition of syncope following upon injury It is a marked feature in patients who reach hospital soon after receipt of their injury It is believed to be due to over-activity of the nervous system and two varieties are described.

Psychogenic Shock results from stimulation of the medullary centres by psychogenic impulses Distress, fear terror and physical pain even without injury are potent factors This type is usually recovered from rapidly if, however the noxious stimuli are sufficiently intense widespread or long-continued, they will predispose to the development of secondary shock.

Neurogenic Shock results from the action of noxious sensory stimuli of somatic and autonomic origin upon the medullary centres This is the type of shock which complicates surgical operations especially those upon the abdomen

Primary shock is produced by a general decrease in vascular tone and reflex inhibition of the heart through the vagi Influences acting through the nervous system, such as direct trauma a severe blow upon the abdomen a laparotomy or psychic stimuli bring about a diminution of constrictor tonus resulting in vasodilatation. A fall in blood pressure follows this latter a continuation of which leads to

a diminution in the venous return to the heart Anoxia develops later causing further serious complications (Raven)

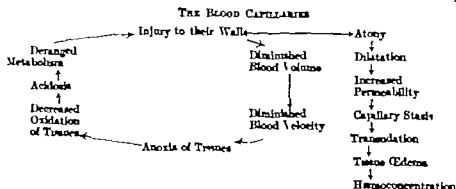
Clinical Picture—Primary shock develops immediately after receipt of injury It may rarely cause instantaneous death when the great sympathetic centres *e.g* the solar plexus are affected Usually its duration is short and in difficult cases Whitby suggests that if the blood pressure remains below 100 after one hour secondary shock has made its appearance The patient appears to be in a prolonged fainting fit ushered in with feelings of great weakness Pallor and cold sweating are present together with a fall in blood pressure Pulse rate is slow and its volume poor while respirations are slow and shallow The fall in blood pressure is not serious provided the respiratory centre continues to function well The extremities are usually warm owing to peripheral dilatation If the condition is not speedily fatal the stage of reactions sets in being heralded by disappearance of pallor improvement in pulse volume and an attack of vomiting A careful record of pulse and blood pressure must be taken every fifteen minutes (Raven)

Treatment—In mild cases a short rest and a simple stimulant suffices More severe examples are treated in recumbency with hot-water bottles or a radiant heat cradle and all noxious stimuli either of psychogenic or neurogenic origin eliminated. Fear and despair must be counteracted every injured part protected or splinted and hæmorrhage controlled. Morphia may be used in small, but never in large doses A blood transfusion should not be given in undoubted cases of primary shock. If however doubt exists as to the presence of early secondary shock then a transfusion is justifiable All our efforts both in diagnosis and treatment are directed toward the prevention or immediate recognition of secondary shock

SECONDARY SHOCK

Pathology

That little is known of the pathology of secondary traumatic shock the multitude of etiological theories goes to prove Before we inquire



into its possible causation let us examine the bodily changes it entails. Raven has embodied most attractively the sequence of events and the interplay of different factors at work in the above diagram

This is described as the vicious circle of secondary shock, and if it is not broken death is inevitable

We will now pass on to a consideration of the various theories

1 **Loss of Blood and Fluid.**—In so far as the principal manifestations are so closely linked with changes in the circulatory system, secondary shock has been termed by Blalock hæmatogenic. This worker followed by many others recently is inclined to regard local loss of blood as the chief etiological factor Important in initiating shock it undoubtedly is but it does not explain many of the phenomena seen in these patients. We deplore the tendency evident in recent years to speak of hæmorrhage and shock as identical states

2 **Presence of a Toxin.**—After the First World War the views of Cannon and Bayliss supported and elaborated by Dale and Laidlaw were widely accepted. They postulated the presence of a toxin derived from the traumatised area circulating in the blood stream. Histamine and similar H substances, as we have shown in Chap. I play a local part in the pathology of acute inflammation but all recent work has proved beyond doubt that they have no relation to secondary shock.

3 **Nervous Stimulation** has once again been revived as an etiological factor This theory suggests that nervous impulses from the site of injury bring about a disturbance in the vagosympathetic system Lorber s experiments seem to demonstrate that the nervous system undoubtedly exerts a powerful influence in the production of shock.

4 **Vasoconstriction and the Adrenal Cortex.**—Excessive adrenal activity has been held to account for the vasoconstriction which is present in the earlier stages. It is probable that this is an effect rather than a cause of shock in the depressed state of the circulation vasoconstriction protects the vital centres and is therefore a defensive reaction

The functions of the adrenal cortex have been questioned in another way The later phases of Addison s disease severe shock and bilateral adrenalectomy all produce a similar condition in the blood, there being an increase in the non protein nitrogen and a decrease in sodium and chlorides Moreover Coller has pointed out that shock is reduced by a proper maintenance of the balance between fluid blood chlorides and the sodium potassium ratio The probable explanation however is that secondary shock calls urgently for cortical hormone and early cases may derive benefit from injections of cortin or eucortone.

Clinical Picture

The patient lies very still in an apathetic condition. If conscious his mind is clear but listless but as shock deepens unconsciousness and delirium make their appearance The cheeks and eyes are sunken the nose pinched and the brow creased the skin is cold and clammy and presents a marked pallor which later merges into an ashen hue Cyanosis is present and the finger-tips nose ears and lips assume a livid tint The tongue is dry and furred and great thirst is complained of

Blood pressure and pulse rate are the most important signs the

former falls steadily as the condition progresses, at first being about 100 and then dropping to 50 or lower Its return to 100 is the surest criterion of the success of resuscitation methods Pulse rate is more variable as it may be normal or even slow but in general it rises as the pressure falls.

The heart sounds are faint and a tic-tac or gallop rhythm may be present The apex beat is neither to be seen nor felt and all peripheral veins are empty and collapsed so that it may be quite impossible to introduce a needle for transfusion Respiration varies little in the early stages but later deep breathing is interspersed with short rapid *respirations* *Cheyne-Stokes breathing* may be seen and the end is ushered in with irregular gasping movements assisted by forced use of the accessory muscles of respiration

The output of urine is di minished but its specific gravity is not markedly raised. Thirst and vomiting are constant symptoms and incontinence of both sphincters occurs before death

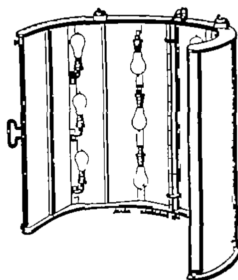


Fig 63

A large radiant heat cradle (*Allen & Hanburys*)

Treatment

A **Prevention.**—1 In Surgical Operations —Fear and anxiety must be allayed and the patient convincingly assured of a successful outcome All unnecessarily rigorous preparation should be avoided and a peaceful night's sleep obtained with the aid of bromide medinal or similar sedative

Many patients by reason of their disease are suffering from malnutrition *e.g* in pyloric obstruction or from dehydration Maintenance of the body's water balance requires about six pints of fluid in twenty four hours and this amount will need to be increased if vomiting and diarrhœa occur Five per cent glucose saline is given by either rectal or intravenous drip infusion and if acidosis is present sodium bicarbonate must be added. If the plasma proteins have fallen below their normal concentration a plasma transfusion is indicated. Similarly many patients come to operation suffering from secondary anæmia as a result of either hæmorrhage or disease they will require a blood transfusion before operation In grave emergency when hæmorrhage is threatening life (as in repeated hæmatemesis from a gastric ulcer) we may be forced to operate when the hæmoglobin is as low as 35 per cent., but when possible surgical intervention should be delayed until the reading has reached 70 per cent

During operation rough handling must be avoided Of the many great lessons taught by Moynihan the paramount importance of

gentleness was the greatest. Exposure of internal structures and hæmorrhage are reduced to a minimum and clean cutting always takes the place of tearing. As small a surface area as convenient is displayed and warmth is carefully conserved during operation as well as during transit to and from the theatre. When facilities exist a patient should be moved direct from the table to a warmed bed, which is then removed to ward or room. Heat is most conveniently provided by radiant-heat cradles (Fig. 63).

2. IN INJURED PATIENTS.—In peace an injured person usually reaches hospital so quickly that shock may be successfully prevented. In the bombing of cities casualties also were frequently brought with commendable speed. But generally speaking battle casualties were delayed in transit to surgically equipped hospitals and first-aid measures assumed great importance. Again gentle handling in first dressing and in transport is essential. Hæmorrhage is controlled by firm bandaging or tourniquet and the injured part is immobilised. Morphia (gr. ½) should be given to allay pain and the time of its administration *must* be noted on the casualty card. Hot drinks may be given provided no abdominal wound is present.

B. **Active Treatment.**—We have shown that unless the vicious circle of shock is broken death must ensue and the earlier this is done the better. We shall describe the measures to be adopted when battle casualties are arriving in considerable numbers, but the general principles apply equally to single patients in times of peace. It may be said that a detailed description of the method of receiving a large number of casualties should no longer be required. We would remind such critics that there remain accidents in the air, on railways, in mines, in large industrial concerns and on the roads which may provide such a sudden influx of seriously injured patients that an unprepared and inexperienced hospital casualty organisation may break under the strain with serious results for gravely injured people. The following description therefore has been allowed to stand exactly as it was written during the aerial attack upon London.

1. THE RECEPTION UNIT.—A ground plan of the unit at St. Mary's Hospital is given here (Fig. 64) which functioned without a hitch throughout the bombing of London. Casualties are received in the reception room which has six tables, each with a pair of trestles to receive a stretcher. Slung on each pair is an inverted "Restor" heat cage (Fig. 65) and at each table sits a reception clerk (in our case one of our almoner staff). A senior medical officer is in control, and every patient is carefully examined and the nature and extent of his or her injuries are assessed. Full particulars are entered upon the casualty card which is also stamped with a coloured star[1] indicating the patient's destination, for it is at this early stage that this vital decision must be taken. Although rest, a minimum of handling and preservation of body heat are desirable, patients must be thoroughly examined lest a grave internal injury be altogether overlooked. The patient is then sent to either (1) the resuscitation unit, (2) the pre-

[1] Coloured arrows prominently displayed in the corridors guide stretcher bearers to their proper destination.

operation room (3) the main surgical wards (4) an observation ward or (5) to the casualty department for minor dressings It is of great

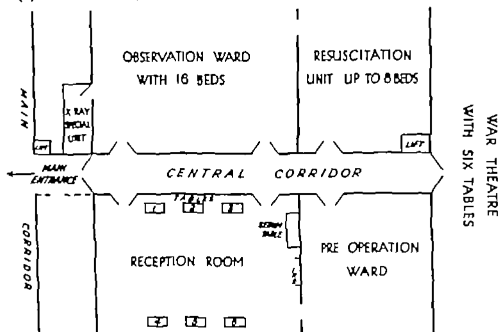


FIG. 61

Ground floor plan of war surgical unit at St Mary Hospital.

advantage if the whole unit together with the theatre is contained in one compact entity on the same floor as in our plan If this is impossible then the resuscitation unit must be adjacent to the theatre

2 RESUSCITATION UNIT —The efficacy of this life-saving organisation depends upon team work the training of which calls for as much intensive practice as does that of first line assault troops The ideal type of man to be in charge is an experienced medical registrar Junior medical officers nurses and students are under his command and each knows exactly what his or her duties are The room must always be ready for instant use at any time of day or night and its temperature is maintained despite any considerations of fuel economy (the unit is there to save lives not fuel) Each bed is made up with a large radiant heat cradle in position and every piece of apparatus ready in its appointed place The whole unit is ready for action the moment the light switch is turned on at the door Finally let us

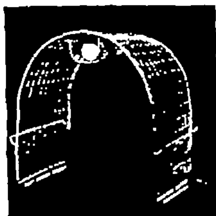


FIG. 63

The Restor electrically heated resuscitation cage. (*Surgery of Modern Warfare.*)

CHAPTER IX

ULCERATION AND GANGRENE

ULCERATION

ULCERATION is the molecular or cellular death of superficial tissues leading to loss of substance and is due to the action of a traumatic infective or neoplastic agency An ulcer therefore means the loss of epithelial and the exposure of subepithelial tissues in an area of skin or mucous membrane The varieties and appearances of ulcers are so numerous and the ulceration is so often merely symptomatic that a complete classification is not feasible here It is most convenient for the student of general surgery to classify them by their causation.

1 Simple Non specific Infections (Staphylococcal and Streptococcal)
   - (a) Vascular defect e.g varicose ulcer gravitational ulcer
   - (b) Trauma or Pressure e g too tight splinting or plaster bandaging over gouty tophi or retained foreign bodies
   - (c) Thermo-Electro-Chemical
   - (d) Neuropathic e.g bedsores perforating and trophic ulcers.

2 Specific Infections
   - (a) Tuberculous—varying types in the skin and all mucous membranes
   - (b) Syphilitic—varying types in all stages
   - (c) Ducrey s soft sore anthrax actinomycosis and diphtheria.
   - (d) Various intestinal infections typhoid, dysentery cholera and stercoral ulceration.

3 Neoplastic i.e. carcinoma sarcoma and rodent ulcer

These conditions may be termed the *exciting causes* the occurrence and behaviour of an ulcer however will depend largely on certain *predisposing causes* General debility and wasting from other serious diseases such as diabetes, chronic nephritis heart disease or *septicæmia not only predispose to ulcer formation but also retard its healing*

The Clinical Appearances should be carefully studied in order that diagnosis may be facilitated

1 *Position Shape Size and Number.*—The anatomical site is of some importance e.g a varicose ulcer so frequently affects the lower half of the leg while syphilis affects the upper half. Similarly the shape may give an indication of the causative organism. Multiple

ulcers scattered over the body suggest a generalised constitutional disease e.g., syphilis or tubercle while multiple lesions in a small area suggest seeding out or spread by some pyogenic or parasitic factor

2 METHOD AND RATE OF PROGRESS —Steadily maintained extension points strongly to new growth rapid onset and quick healing suggest simple non-specific ulceration simultaneous healing and extension is characteristic of some specific lesions and extreme chronicity points to a definite reason for the absence of healing

3 THE FLOOR is usually sunken beneath the healthy surface It is raised in fungating growths and in healing ulcers when the granulations are exuberant The type of tissue covering the floor must be noted e.g red vascular and acute granulation tissue the pale flabby and anæmic granulations of tuberculosis the fibrous avascular floor of syphilitic ulcers and the necrotic debris of the new growth

4 THE EDGES reveal much Sharply defined red and vascular edges denote extension rounded smooth grey ones point to chronicity raised everted and necrotic they are diagnostic of a squamous-celled carcinoma the clean cut punched out edge is syphilitic and the thin blue undermined one suggests tuberculosis or other chronic inflammation

5 THE SIDES are of course continuous with the floor but their disposition is important Some ulcers have slowly shelving walls which pass gradually into the floor others have sharply sloping walls which meet at an angle without any real floor Such a fissured ulcer is seen in tuberculous disease of the tongue

6 THE BASE is that zone of tissue immediately surrounding and underlying the ulcer The presence or absence of induration is of importance

7 THE DISCHARGE.—Free pus indicates an active extending ulcer mixed pus and serum in moderate amounts are to be expected during healing Scanty sero- or muco-pus is seen in tuberculosis Healthy granulations bleed readily but the granulations of tuberculosis and syphilis do not Certain diseases produce specific cells or constituents in the discharge which are diagnostic e.g the golden yellow granules in actinomycosis

8 RELATIONSHIP TO SURROUNDING STRUCTURES —Fixation of an ulcer to underlying tissues must mean either a chronic inflammation of long standing or malignancy

9 THE LYMPH DRAINAGE ZONE may be affected in many cases of ulceration The clinical appearance of the enlarged glands may be of diagnostic value

SIMPLE NON-SPECIFIC ULCERATION

The Pathology of this condition is divided into three stages

1 STAGE OF ACTIVE EXTENSION—The Spreading Ulcer —The conditions present are exactly similar to those in the wall of an abscess cavity The surface is covered with dirty greyish disintegrating tissue and no granulation tissue is present the edges are *well-defined* and acutely inflamed the base is thickened and œdematous and pus is being discharged

B STAGE OF PREPARATION FOR HEALING—The Transitional Ulcer — The active extension has been arrested and the surface is becoming clean by the shedding of necrotic tissue No granulation tissue has yet appeared but the surface is now rosy in colour instead of fiery red, and has a glazed appearance as if a thin glistening film had formed over it. The thickening and œdema of the base have disappeared. The rosy film gives place to numerous little red specks which increase in size till they coalesce and finally the whole area is covered with granulation tissue In acute cases this stage lasts so short a time that it is hardly recognised. Its imperfect development and its persistence constitute a chronic ulcer

C STAGE OF REPAIR—The Healing Ulcer —The condition now present should no longer be called an ulcer for it is simply a healthy granulating wound. Its surface is covered with granulations the edge is actively proliferating and sending in a layer of epithelial cells to cover the surface, and the zone immediately beneath the granulations is changed into scar tissue Healing is complete

Clinical Features—1 THE ACUTE ULCER.—Almost every ulcer has an acute phase at its inception, but the term is applied to those which are characterised by rapid progress and a marked tendency to heal They often follow slight trauma and are not infrequently multiple. Examples are acute dyspeptic ulcers of the mouth and acute peptic ulcers of the stomach and duodenum In the mouth and on the skin they are painful and tender but pass rapidly through the three stages to complete recovery within a few days.

Treatment consists in removal of the cause and rest to the part, which should be placed in the position most suitable to overcome venous obstruction Boracic fomentations or linseed poultices will clean up the surface in the first twenty four hours and eusol dressings will help sloughs to separate After twenty four to thirty-six hours mild antiseptic dressings *e.g* perchloride of mercury lotion (1 1000) flavine or acriflavine in paraffin (1 2000) give excellent results As soon as healing has started flavine or lotio rubra dressings can be combined to advantage with infra red or short-wave therapy once a day

Under such treatment healing is usually complete within a *few* days but very occasionally a rapid extension of the ulceration occurs involving and destroying a considerable extent and depth of tissue. This constitutes the condition of *phagedena* now rarely seen and then in connection with venereal infections of the external genitals, when the penis may be completely destroyed. Repair is followed by extensive scarring and deformity

2 THE CHRONIC ULCER—Causes of Chronicity —If an ulcer fails to heal, some good cause must be present and should be sought for before treatment is undertaken These causes are (*a*) defective circulation in old people leading to venous stasis and congestion especially in the legs (*b*) venous obstruction *e.g* varicose veins femoral thrombosis, etc (*c*) lack of proper treatment especially rest *e.g* a fissure-in-ano which cannot be put at rest until the external sphincter is anæsthetised divided or stretched (*d*) fixation to underlying tissues (bone fascia or muscle) which prevents the efficient development of

healthy granulations and the drawing together of the edges and floor (e) constitutional diseases e.g diabetes anæmia nephritis (f) persistence of the original exciting cause (g) pressure of œdema on the surrounding vessels which leads to a rapid extension of the ulcer (h) artefact i.e. the deliberate prevention of healing by the patient usually if of unsound mind or for the purpose of defrauding employers or insurance companies and eliciting sympathy

CERTAIN VARIETIES OF CHRONIC ULCER

Varicose Ulcer is very common among elderly women of the poorer classes who have suffered from varicose veins for many years, as a result of which the skin is pigmented and thickened from a chronic infective dermatitis (the so-called varicose eczema Fig 67) The actual ulceration is brought on by dirt rubbing of clothes and neglect The surface is rough irregular and glistening dirty yellow in colour and a few patches of coarse granulations are present The edges are firm and well-defined, the discharge is seropurulent and profuse and the base is densely indurated and adherent to underlying tissues If the surface of the tibia is in the base an area of periostitis forms beneath the ulcer and later a diffuse osteoperiostitis may follow The ulcer is usually seen in the lower half of the leg and on the antero-internal and antero-external aspects. It may spread gradually round the circumference of the leg and by obstructing lymphatics and veins give rise to a condition of pseudo-elephantiasis



FIG. 67

Varicose ulcers of left leg; scars of healed ulcers on right.

Eczematous Ulcers are superficial and have a copious discharge which leads to a spread of the eczema

Irritable Ulcers are seen near the ankle only They are small, have no connection with varicose veins and are exquisitely tender owing to the exposure of living nerve endings.

Pressure Ulcers are commonly caused by the careless application of splints and plaster bandages over prominent bony points such as the heel, the malleoli of the ankle and the lower end of the radius and ulna. The skin over a rapidly growing innocent growth over the bone in a conical stump and over a gouty tophus may ulcerate Bed-sores may be purely pressure in type but are usually associated with nerve lesions.

Neurotrophic Ulcers are indolent and most difficult to treat. They occur in lesions of the peripheral nerves and of the central nervous system e.g., tabes dorsalis transverse myelitis anterior poliomyelitis and syringomyelia. The ulceration is due to pressure on the desensitised and devitalised skin and therefore occurs over the bony -

points of the sacrum, pelvis and lower extremity The most serious example of this condition is the bed-sore over the posterior surface of the sacrum and coccyx. The skin gives way and the ulceration progresses till the bone is laid bare and an infective spinal meningitis ends the scene

Thermo-electro-chemical Ulcers are not common as these agents cause burns or gangrene rather than local ulcers In general, they tend to be indolent in spite of a fresh healthy appearance Diathermy burns, in particular take a long time to heal.

Meleney's Undermining Ulcer is a rare condition occurring in any wound or in an area of lymphatic glands It is due to an anaerobic hæmolytic streptococcus which assumes an aerobic habit on culture within forty-eight hours

The characteristics of this type of ulcer are these After an initial stage of local infection extension occurs slowly but persistently below the skin, which at first shows little gross alteration. Later daughter ulcers and peripheral sinuses make their appearance and infection travels along vessels nerves and fascial planes The base is covered with greyish gelatinous anæmic and shaggy granulations Clinically there is mild pyrexia and moderate pain.

Treatment consists first in a thorough exposure of all ramifications, pockets and sinuses and second in syringing a suspension of zinc peroxide cream into every part of the wound which is then lightly packed with gauze soaked in this chemical product (p 34)

TREATMENT —1 *Prophylactic* treatment if taken in hand properly will prevent almost all chronic ulcers Pressure ulcers should be avoided by care in the application of splints and plaster bandages, by the protection of prominent areas and by careful nursing Special attention is needed in all very seriously ill patients to preserve the skin over the bony points in the back. The appearance of a bed-sore in a paralysed patient cannot always be avoided, but it is rightly regarded in most cases as a serious reflection on the skill of both doctors and nurses First the skin must be kept clean by washing with soap and water three times a day after which it is carefully dried secondly three minutes are spent in *gentle* rubbing of the whole area with a stimulating lotion or a mild antiseptic ointment thirdly hardening of the skin is developed by the application of spirit lotion or eau-de-Cologne If there is incontinence of fæces or urine the routine must be gone through every time soiling occurs. The patient should lie on a water or air bed no creases or seams should be allowed in the sheets and crumbs or other foreign bodies in the bed avoided.

2 *Removal* of the *Cause* may apply equally to prevention and treatment Jagged teeth foreign bodies and all sources of infection are to be removed and all predisposing causes treated *e.g* varicose veins should be injected in the neighbourhood of varicose ulcers

3 *Treatment* of the *Ulcer* itself Many ulcers are due to causes which demand specific treatment for example syphilitic ulcers. The treatment of an acute ulcer has been described and is a very simple matter whereas the chronic ulcer may be indolent and very unsatis-

factory to treat The cause of the chronicity should be investigated and every effort made to remove it

Local Applications—The ulcer should first be cleaned up all sloughs and debris being removed or encouraged to separate by hot boracic fomentations for forty-eight hours followed by eusol dressings for the next few days When the wound is clean applications to stimulate the granulation tissue into activity are required Lotio rubra is applied on several thicknesses of gauze which are kept moist by frequent renewal scarlet red ointment is a powerful stimulant but it must not be allowed to spread over the skin and is therefore applied on a piece of lint accurately cut to fit into the ulcer the surrounding skin being protected by a mild antiseptic ointment generously applied. Pepper s ointment is another valuable preparation especially so in bed-sores Infra red radiation and short-wave therapy produce healing in apparently hopelessly incurable ulcers even when neuropathic, and are the most powerful therapeutic agents available They should be given twice daily under skilled supervision Immobilisation of the affected part and rest in bed will accelerate healing but it is not always possible to keep patients off their feet Dickson Wright has shown that varicose ulcers can be induced to heal by firm strapping of the foot ankle and leg with elastoplast This is easier to apply and is more satisfactory than the old Unna s paste stocking

Recently the treatment of wounds and acute inflammations by chemotherapy and immobilisation has been directed to more chronic lesions. Indolent ulcers resisting less radical treatment should be insufflated with penicillin or sulphanilamide powder and completely immobilised in plaster of Paris It can be said in general that the more chronic an infection the less will be the response to chemotherapy

Operative Measures—Under certain conditions local excision and suture may be the ideal treatment If an ulcer is easily accessible and has not responded to treatment, and if no condition is present to delay healing in the scar excision should be considered. Amputation may become advisable because of the large extent of the ulcer its resistance to treatment its persistent recurrences the presence of pseudo-elephantiasis or the onset of carcinoma Skin grafting will hasten healing cut short a tedious convalescence and prevent subsequent deformity provided that the conditions are suitable In chronic ulceration the conditions are rarely suitable for the causes of the chronicity are just those which militate against the success of grafting It will therefore be reserved for those patients in whom the chronicity has been overcome and the surface is in a healthy healing state

Skin Grafting is the process of transplantation of the whole or part of the thickness of the skin from a healthy area to a granulating surface in order to bring about more rapid epithelialisation of the latter and to obtain a more pliable scar which will not contract and produce deformities The area to be grafted must be clean and healthy and the infection under control. This is estimated by the number of organisms counted in loops of discharge taken from the surface The wound should be dressed with normal saline for at

least seventy two hours before grafting There are four methods of grafting :—

1 *Reverdin's Method* is the oldest and has returned somewhat to favour of recent years An area of skin is lifted up with the point of a needle a pair of fine pointed forceps, or by a hair and a small islet of superficial skin snipped with sharp-pointed scissors. Numerous

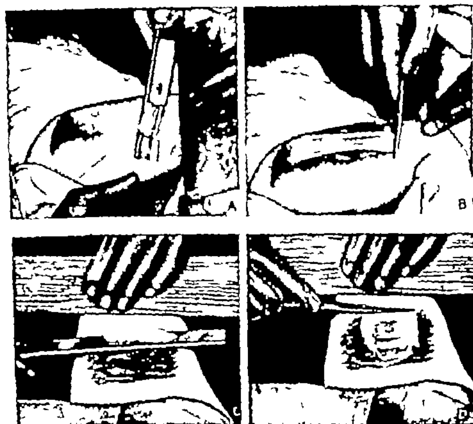


FIG 68

A, Large thick razor graft cut from outer side of child's thigh with simple knife-and-board technique

B, Removing the graft. Its opacity indicates its thick character

C, Thin razor graft cut from inside of right arm, using simple knife-and board technique.

D Dividing the graft. Note the thinness of the graft

(*Surgery of Modern Warfare*)

islets are cut and planted out on the granulating bed To-day this method is generally known as Pinch Grafting, which is restricted to surfaces still obviously infected. Its æsthetic result—both at recipient and donor sites—is much inferior to the Thiersch method

2 *Thiersch's Method* is of great value and is in most common use Strips of cuticle 3 in by 2 in. are cut with a razor from the skin of the thigh so as to include the *tips* of the papillæ of the true skin (Fig 68) These are laid on the surface to be grafted in such a way that each overlaps its neighbour and the peripheral grafts overlap the skin edge

Care must be taken to prevent the rolling in of the edges and to express every bubble of gas from beneath the grafts which are dusted with penicillin powder and maintained in position with a wide-meshed gauze impregnated with medicated vaseline (e.g. tulle gras) and are left undisturbed for ten days.

It is important that the graft be pressed evenly and firmly against its bed. When the walls of a cavity are to be covered the graft must be held in place by casts made of paraffin impregnated gauze or dental stent.

3 *Wolfe's Graft* comprises the whole thickness of the skin from which all subcutaneous fat must have been removed. It is sutured to the freshly trimmed skin edge but its vitality cannot be relied upon and *many fail to take*.

4 *Pedicle Grafting* is of two types. The fixed base pedicle graft is exemplified by the raising of a flap of skin from the abdominal wall with its base undisturbed. Its free edges are sutured to the margins of the raw area to be grafted on the hand or arm, which is held in position by a plaster bandage. The base is divided ten days later by which time the graft has obtained a blood supply from its new bed. The tubular or movable pedicle graft is produced by a many stage operation the first of which aims at raising a strip of skin from the deep fascia and suturing its parallel edges together to form a tube of skin containing subcutaneous fat and being attached to normal skin at each end. At the end of a fortnight this pedicle contains a central artery which permits of a flap of skin being raised at one end of the tube and being swung into position some distance away to repair defects of considerable size.

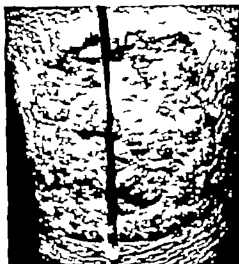


FIG 69

Marjolin ulcer. A squamous-celled carcinoma which has arisen on an old chronic varicose ulcer.

THE COMPLICATIONS arising in and from chronic ulceration have been dealt with, except the change to a malignant growth. Marjolin's ulcer (Fig 69) is the name given to a squamous-celled carcinoma *arising in the edge of a chronic ulcer or in a cicatrix*. An increase in the induration at any one point in the edge of an ulcer combined with eversion should raise the suspicion of malignancy.

Specific types of ulceration are described in the regional sections of this book.

GANGRENE

Death of soft tissue in the human body is called "sloughing" and the dead area a "slough". Sloughing of visible pieces of

bone is termed 'necrosis' and the dead bone is a 'sequestrum.' Gangrene implies the death *en masse* of a functioning unit of the body such as a toe, a finger, a foot, a hand, a coil of intestine or a testis.

THE SIGNS OF GANGRENE

These are (1) loss of pulsation in the arteries of the part; (2) failure of the colour to return to the skin after pressure; (3) loss of heat, the part being dead cold; (4) loss of sensation as soon as the nerves are dead; (5) loss of function, the limb being motionless or the bowel showing no peristalsis; and (6) changes in colour depending on the conditions present, varying from deep violet mottling to dead white. Before the parts are actually dead there is intense pain in the dying nerves, and after gangrene has occurred pain may be referred to the dead part.

TYPES OF GANGRENE

In **Threatened Gangrene** the above signs are present in a mild degree and urgent treatment is called for to prevent tissue death occurring.

Dry Gangrene develops in the absence of infection, when the final cutting-off of the blood supply has been preceded by a gradually increasing arterial obstruction, as the result of which the veins and lymphatics have become adapted to remove the tissue fluids from the limb without the assistance of the normal *vis a tergo*. The affected part becomes shrivelled, hard, wrinkled and dry; the disintegrating blood pigments turn it black and the skin assumes a waxy transparency. The dead tissues are separated from the living by an ulcerating 'line of demarcation,' which is produced by active granulation tissue advancing into the dead tissue from the living margins, at the expense of which the separation is mainly achieved. Each layer of tissue in a limb is not necessarily separated at the same level, the bone in particular surviving to a more distal point, so that the stump after natural separation is likely to be a conical one with the bone protruding beyond the skin. If an extension of the gangrene should occur it is due to a repetition of the original cause at a higher level in the vessels, and the area affected will increase not by local spread but by graduated leaps. It is always associated with severe pain produced by the dying nerves.

Moist Gangrene results from the sudden cessation of the arterial blood supply to a part which remains full of blood, either because the main veins are also obstructed or because the flow in them cannot be maintained in the absence of the normal *vis a tergo*. Two types of moist gangrene are seen.

A ASEPTIC MOIST GANGRENE occurs in the absence of infection when the arterial supply is abruptly cut off without any previous gradual obstruction, and when the death and disintegration of a large mass of soft tissues causes fluid to collect beneath the skin more quickly than it can evaporate. This is sometimes seen in senile gangrene of the lower extremity, in which, while dry gangrene affects the foot, aseptic moist gangrene appears in the calf. The parts may show a variety of colours from black, purple, green and yellow to dead white.

There is little change in the size shape and consistency of the limb and if perfect asepsis is maintained separation occurs by a zone of aseptic ulceration and the dead tissue is quietly cast off In a very few examples evaporation occurs sufficiently rapidly to convert the moist into the dry type of gangrene

B SEPTIC MOIST GANGRENE is much more common It results either from the infection of dead tissue in aseptic moist gangrene and very rarely in dry gangrene or from the infection of living tissues by certain organisms which cause the death of the part The onset of gangrene may be encouraged by the lowered vitality of the tissues from other conditions such as diabetes prolonged illness and neurotrophic lesions The limb becomes greatly swollen and purple green and yellow in colour Blisters containing foul smelling exudate form in the skin the muscles are emphysematous from gaseous decomposition and all soft tissues can easily be lacerated The surrounding zone of living tissue is invaded by the inflammatory process the patient rapidly becomes gravely ill and death from septicæmia often follows If the gangrene spreads it does so by direct extension of the infection into the adjacent tissues If the patient lives a broad line of demarcation is formed and separation occurs chiefly at the expense of the living tissues

THE CHANGES WHICH FOLLOW GANGRENE

These are due to the reaction between the dead and the living tissues and the dead will suffer one of three fates —

1 **Absorption.**—Small areas of dead tissue will be absorbed by healthy granulation tissue containing foreign body giant cells in exactly the same way as the body deals with a catgut suture

2 **Separation by Aseptic Ulceration.**—The line of demarcation is produced by granulation tissue growing from the living margin and digesting the dead tissue A point is soon reached beyond which the nutrition of the advancing granulation tissue cannot be maintained and a line of ulceration is produced. The blood supply of the bone is more extensive than that of the soft tissues and the bone separates at a lower level as a result of which a conical stump forms

3 **Separation by Septic Ulceration.**—The line of demarcation is produced by active suppuration in the living margin due to its invasion by the infection from the dead tissues The final line of separation is definitely higher in the limb than the original level of the gangrene

GENERAL PRINCIPLES OF TREATMENT

In dry gangrene every effort must be made to keep the dead tissues dry and aseptic and in moist aseptic gangrene to keep them aseptic and to encourage and assist them to become dry The limb is lightly bandaged over a generous swathing of sterilised cotton wool and the opposite limb exposed to hot dry air for half an hour during each four hours of the day The general health must be supported and any intercurrent disease appropriately treated. The relief of pain becomes a serious problem and amputation may be called for because the pain

is so severe as to impair the general health and resistance Natural separation takes some weeks, and it is undesirable to continue the use of morphia over so long a period while other drugs may fail to give relief. The details of treatment and the indications for surgical intervention are dealt with under the various types of gangrene In septic moist gangrene the severe inflammatory reaction rather than the gangrene dictates the course of treatment

SPECIAL VARIETIES OF GANGRENE

The classification of gangrene is not easy because more than one factor enters into so many of the varieties The following is based on etiology and will be found both simple and practical.

A Vascular i.e. Ischæmic—

1 Primary arterial degeneration

- (a) Senile — Atheroma. Arterio-sclerosis. Monckeberg's disease.
- (b) Non-senile — Syphilitic and toxic.

2 Pressure on the wall of an artery

3 Thrombosis and thrombo-angiitis obliterans

4. Embolism.

5 Vasomotor — Raynaud's disease. Ergotism Carbolic acid.

6 Traumatic (see *C*).

B Infective—

1 Acute pyogenic — Boils and carbuncles. Cancrum oris Noma vulvæ. Phagedena. Spreading gangrene.

2 Gas-forming organisms — Gas gangrene.

C Traumatic (in reality vascular)—

1 Direct.
2 Indirect

D Thermal, Electrical and Chemical—

1 Burns and scalds.
2 Frost-bite
3 Lightning
4 High frequency electrical currents *e.g* diathermy
5 Escharotics

E Toxic—

Diabetic
Ergot poisoning (see *A* 5)

F Neuropathic

VASCULAR GANGRENE

Senile Gangrene is the commonest form of gangrene in civil practice occurring in both sexes after the age of 55 years It usually affects the toes and feet but is also met with in the hand nose and ears. The predisposing causes are (1) degeneration of the smaller arteries with or without atheroma in the larger trunks (2) weak heart action and low blood pressure and (3) lowering of the local nutrition and general resistance by anæmia nephritis diabetes and other diseases The blood supply has therefore been slowly but progressively diminished and gangrene when it supervenes is of the dry type The determining factors are those which result in thrombosis

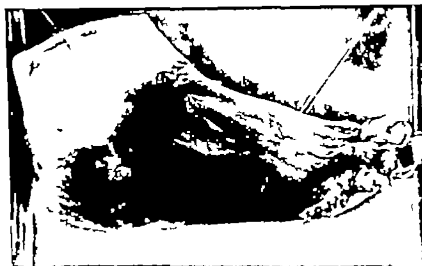


FIG. 70
Senile dry gangrene of the foot.

either in the peripheral arteries or in the main trunks Thrombosis of the large vessels may be due to slight injury or to the deposit of clot on a diseased vascular endothelial lining Cutting a corn the rubbing of a toe by a new boot knocking the foot against a chair or table or exposure to cold may be sufficient to precipitate a block of the smaller arteries The extent of the gangrene obviously depends on the level to which the arterial obstruction extends (Fig 70)

Symptoms —The patient will have complained of painful cramps in the calf after walking short distances of numbness and pins and needles and a sensation of coldness in the legs The gangrene starts as an area of redness and inflammation which later becomes dry and shrivelled. The dying tissues are always the seat of severe pain, but in the early stages the general condition is good, whereas later exhaustion from the continual pain lack of sleep and toxic absorption lead to fever restlessness wasting and delirium. Finally cardiac renal or pulmonary complications usher in the end.

Treatment —Threatened gangrene is treated on general principles

patient that the gangrene spreads with alarming rapidity involves the whole thickness of the cheek and exposes the alveolar margin There is a foul discharge much of which is swallowed and the smell is both nauseous and penetrating The progress of the infection is marked by rigors and a high temperature by toxæmia and later by septicæmia The prognosis is extremely grave



Fig 72
Cancrum oris from the notorious German concentration camp, Belsen

Treatment is prophylactic that is in attention to the general health and to dental caries The steady improvement in conditions of living and the admirable work of the infant welfare organisations has practically eliminated this terrible disease In the early stages energetic treatment with penicillin and sulphadiazine and short wave therapy may succeed in localising the infection. Later all infected tissue must be excised and the resulting deformities made good by skin grafting or plastic reconstruction.

NOMA VULVÆ is a similar condition affecting the external genitals of young children and in spite of its name can occur in boys It has also become practically non-existent but in recent years there have been some examples in fever hospitals among children gravely ill with measles

PHAGEDENA or hospital gangrene " was only too common in the pre-antiseptic era It rarely occurs in this country to-day and the term is used chiefly in connection with the destructive ulceration of the penis which occasionally complicates venereal infection

SPREADING GANGRENE was once synonymous with hospital gangrene but the latter having become extinct it is now used to describe a special type of lesion It is a complication of wounds of the trunk, usually those established for drainage of deep-seated abscesses In the author s personal experience it has been met with only in empyema wounds and in every case those accompanied by a pleuro-bronchial fistula It is described by Frank Meleney as being caused by a symbiosis of an anaerobic non hæmolytic streptococcus with a hæmolytic *Staphylococcus aureus* he has named the process synergistic gangrene At the edge of a previously healthy wound a thin bright red line suddenly appears and the skin margin becomes everted and raised

This zone never more than ½ in broad has a surround of pale pink hyperæmia into which it rapidly and persistently advances As it progresses the tissues left behind become grey white greatly thickened and indurated These changes affect the whole depth of both skin and subcutaneous tissues but never go deeper than this In the absence of treatment the gangrene spreads irresistibly

Treatment must be immediate and drastic No matter how extensive it may be the whole area must be excised with a ½ in of normal skin. The wound edge is then undercut for another ½ in. and the recess thus formed and the whole surface is packed with Meleney's zinc peroxide cream This must have a high free oxygen content (40 per cent) and can be obtained in this country only from the firm of Messrs Laporte of Luton Bedfordshire

Gas Gangrene is described on pp 35 to 38

TRAUMATIC GANGRENE

Direct Traumatic Gangrene is the result of an injury which destroys the vessels within the local zone of trauma when the parts distal to the injury are deprived of their nutrition and die Such death of tissue is seen in severe crushes in which a limb is injured by a heavy weight by the moving parts of machinery or by the wheels of vehicles The tissues are crushed or pulped and the vessels torn lacerated crushed or thrombosed. Gangrene is not likely to follow in young healthy people but in the old and frail a moist type may set in

The pressure of splints plasters and bandages may produce local gangrene as has already been described (p 176) and in the production of a bed-sore direct trauma plays some part.

Indirect Traumatic Gangrene is produced by an injury which obstructs the main vessels and the parts which die are at some distance from the vascular lesion. The causes are

1 Ligature of a main artery which will cause gangrene only if the parts are already unhealthy from long-standing arterial disease It is seen only in the lower extremity in which the toes will be the seat of dry gangrene This type may be prevented in a certain number of cases by simultaneous ligature of the vein. When gangrene is established the part should be kept dry and aseptic until a well marked line of demarcation is present and then the dead tissue removed by an amputation just above it

2 Sudden occlusion of both artery and vein will lead to moist gangrene in the majority of people though in the young and healthy the collateral circulation may develop sufficiently rapidly to restore the nutrition of the limb Gangrene does not occur if there has been an old long-standing arterial obstruction because the collateral circulation is already in full service

Occlusion of both vessels by external means is seen in a strangulated hernia torsion of the testis, strangulation of the penis by a ligature round the base or of a finger by a ring which is too tight The gangrene will be moist or dry according to special circumstances and amputation or resection will be needed

3 Subcutaneous rupture of a vessel may lead to gangrene from compression of the neighbouring main vessels by extravasated blood. This should be prevented by ligature of the ruptured vessel and removal of the clot.

TOXIC GANGRENE

Diabetic Gangrene.—Three factors are at work in the production of gangrene in patients with diabetes mellitus an arterial degeneration especially in the anterior and posterior tibial vessels a diabetic neuritis and a condition of the blood favourable to the development of sepsis. Gangrene does not occur in young people with diabetes, and it is probable that the most potent factor is the arterial change of a senile type It is important to distinguish between true diabetic gangrene and senile gangrene associated with a toxic glycosuria

The gangrene starts in any point of sepsis which has followed trivial injury or the cutting of a corn and it spreads rapidly For this reason care of the feet is an essential part of a diabetic s regime One of the most important members of a diabetic clinic is a chiropodist and every patient must be taught the great importance of foot hygiene It is usually moist very foul-smelling and leads to extensive sloughing of the skin There is so much inflammation in the surrounding living tissues that there is no clear line of demarcation. Early cases however do occur in which an aseptic moist gangrene can be converted into the dry type Pain is usually severe owing to the diabetic neuritis and the gangrene may precipitate an attack of coma The prognosis is always poor and amputation should be performed at the earliest opportunity

Thermochemical Gangrene has been described on pp 131 to 142 and **Neuropathic Gangrene** likewise on p 167

R M HANDFIELD-JONES

CHAPTER X

GENERAL SURGICAL TECHNIQUE

THE student entering the surgical wards to-day for the first time finds it difficult to believe that modern surgery is but eighty-odd years old and he can have no conception of the terror that was surgery before the introduction of the antiseptic and aseptic era The world owes to Louis Pasteur the discovery that disease was due to microbic invasion and to Lord Lister the application of that observation to the revolution of surgery and the relief of untold suffering of millions of human beings

ANTISEPTIC SURGERY

This premises the presence of organisms in a wound and seeks to destroy them or to prevent their growth by chemical means Some of these antiseptics are true germicides, but others are capable only of preventing the multiplication of organisms whilst some potent *antiseptics are inapplicable to the human being owing to their toxicity* Antiseptic methods of sterilisation are still employed for certain purposes but in operative technique they have been replaced by asepsis The following are among the most useful antiseptics in common use to-day

Carbolic Acid belongs to the Listerian epoch It is so potent and so destructive of human tissue that its use is restricted to certain specific purposes Pure carbolic acid is used in minute quantities as a cauterising agent to sterilise septic areas *e.g.*, the stump of an appendix after its removal it is used in solutions of glycerin in gynæcological practice as a paint for the interior of the uterus after curettage in very dilute solutions as the basis for gargles and throat sprays and in the injection treatment of internal hæmorrhoids It must never be used in a compress or dressing on the skin for fear of its producing ulceration or gangrene

Biniodide of Mercury is extremely toxic and must never be used in open wounds but it is a valuable agent for the sterilisation of the patient's skin and the surgeon's hands It is used either as an aqueous solution (1 1000) or in alcohol (1 500 parts of 90 per cent alcohol) It is the universal custom to tint this solution with eosin.

Iodine is the most popular of all antiseptics but it is doubtful if its virtues justify its expense It is used in 2 2½ and 5 per cent solutions in alcohol chiefly in the routine preparation of the skin before operation. It is quite useless unless the fats of the skin have previously been removed by acetone or ether It is also the inevitable standby in every first aid post for all wounds.

Picric Acid is also used to prepare the skin before operation, as a 2 per cent solution in alcohol It has the great disadvantage that its yellow stain persists for several weeks It used also to be a popular application as a 1 per cent. solution in the treatment of burns.

Alcohol is rapidly going out of favour owing to its high cost and the doubt thrown by bacteriologists upon its antiseptic value. Industrial alcohol remains a useful, if extravagant, method of sterilising needles, scalpels scissors and skin.

Dettol has become firmly established as a useful all round antiseptic. As an aqueous solution or cream it is used for preparing the skin both of the patient and the surgeon, being especially popular with gynaecologists. It has an added virtue in not damaging the hands however lavishly and frequently used.

C.T.A.B. (Cetyl triammonium bromide) introduced during the war to replace surgical spirit has had a considerable vogue for preparing skin

Eusol, Dakin's Solution, Chloramine T or **Di Chloramine T** are members of the hypochlorite group of antiseptics which act by virtue of their strong oxidising action. They are not very stable in solution or when warm but have a place in the treatment of infected wounds by continuous irrigation.

T.C.P. (Trichlorophenylmethyliodosalicyl) is another proprietary preparation greatly in favour especially among dental surgeons and as a prophylactic against laryngeal and pharyngeal infections. It may be used both for internal and external medication, on wounds and in mucous surfaces

Flavine—*a coal tar derivative*—*is used either* as an aqueous solution (1 1000) or in suspension in paraffin. It is an admirable dressing for open wounds particularly just after the worst of the infection has passed off and the period of regeneration set in

Hydrogen Peroxide is another agent which acts chiefly by virtue of its oxidising action. It is useful in dealing with anaerobic infections and in the removal of dressings which caked with dried blood and discharge are adherent to the wound surfaces

Lysol is both cheap and effective It is highly poisonous however and should not be allowed to come in contact with the skin.

Formalin *is not suitable as an antiseptic in contact with the* tissues but it has a special place in the sterilisation of such surgical equipment as cannot be boiled, and is used for all gum elastic catheters and bougies etc Owing to its irritant nature these instruments must be washed in a mild sterile solution before use

Chemotherapy forms the subject of Chap XI

ASEPSIS

Asepsis aims at preventing the entrance of organisms into wounds and so dispensing with the use of antiseptics *all of which are likely* to injure living tissues if they are of any real value in the destruction of the infecting organisms

Pathogenic organisms are introduced into the human body from

without and if everything which is to come in contact with the patient s tissues has been sterilised before use the risk of introducing micro-organisms is reduced to a minimum The most efficient method of killing bacteria and their spores is the use of heat either by boiling indestructible instruments or by exposing towels gowns dressings etc to steam In large hospitals all sterilisation is done in one main central high pressure plant in which superheated steam is the active agent Smaller plants in which the pressure is lower are available and are as efficient though not so rapid in their action. All operation and dressing material is placed in special drums of which the outer case is double and so perforated and able to slide that the apertures can be made to coincide or close as required. They are loosely packed with dressings and loaded into the steriliser with the openings coinciding to allow full access to the steam. After their removal the outer case is closed and the drums stored for use

Two essential elements in every operation can never be sterilised except by chemical antiseptics viz the patient s skin and the surgeon s hands but with these exceptions modern surgical technique is based on the principles of asepsis The technique of individual surgeons must necessarily differ in minor details but the broad outlines of theatre management are uniformly adopted

THE OPERATING THEATRE

The theatre in a large hospital is part of a suite of rooms These include a surgeons changing room and bathroom one or more rooms for the storage of various requisites and suitably arranged with hot cupboards in which to keep large flasks of sterile saline a room for needlework and the repair of instruments and gloves a room reserved for the induction of anaesthesia and finally the operating theatre itself This should have three annexes communicating with it by doorless arches one containing the sterilisers (enclosed in draught cupboards) for the instruments bowls and saline solutions a second with hand basins and drum holders where the surgeon and his assistants scrub up and robe and a third fitted with sinks for the reception, collection and disposal of all dirty towels dressings used lotions etc

The theatre should be as small as comfort and efficiency permit It must be equipped with a heating system capable of maintaining a temperature up to 80 F its floor and walls should be of polished stone glazed brick or white tiles and all corners between the walls and floor must be rounded off The floor should slope to one side towards a shallow gully for drainage The only fixtures on the walls should be the electric fitments for light and power a tube for attachment to the suction apparatus and an X ray viewing box let in flush with the wall If an observation gallery is provided it should run round *three sides* of the theatre at a height of 7 ft. 6 in above the floor be quite narrow screened breast high and reached by a staircase outside the theatre The fourth wall should if possible face north and be occupied com pletely by a window which should be fitted with an adjustable dark blind. The table is made of metal and is adjustable to all positions

required in operations Tables for instruments, for swabs and lotions and for the anæsthetist s equipment are constructed of tubular metal framework with glass shelves. Drum holders are of that pattern which allows the lid to be lifted by a foot pedal Glass shelves for storage of catgut drainage tubes scalpels etc should be in a small recess off and not actually in the theatre.

Artificial lighting by shadowless electric lamps is the best type of illumination and some arrangement of accumulator and lamps must be installed in case of a general breakdown In addition to fixed lighting mobile adjustable reflection lamps are of great value In view of the highly explosive nature of ether vapour and of the many recent serious accidents it is considered undesirable to have any naked light or electric spark in the theatre

No visitor should be allowed on the floor which must be reserved for those actually engaged in the operation and for students under instruction. In addition to such sterile clothes as may be necessary all persons employed on the floor should have special footwear (white canvas shoes, rubber boots or goloshes), which are never allowed to leave the theatre premises

It is not always possible to work in such ideal surroundings but the best surgery can still be done in poor conditions if general principles are adhered to In a private house a large light and airy room can be easily converted. The carpets and curtains must be taken away the walls and floors scrubbed and all furniture removed. The room is then well aired and heated, the floor covered with several layers of newspaper and a dust-sheet temporarily nailed in place over them All that need be provided in the house is an ample supply of boiled water both hot and cold. The surgeon s theatre sister will bring all the bowls ready sterilised as well as the instruments and dressings.

THE SURGEON AND HIS STAFF

In every case the surgeon should change completely if possible into white duck trousers a white short-sleeved shirt and white canvas shoes or failing this into grey flannel trousers, white cricket shirt and white shoes. He then proceeds to scrub his hands and forearms up to the elbows under a spray of hot water with a nail brush which has been sterilised by boiling This process must last for at least five minutes during which he pays particular attention to the nails and to every part of the fingers and hand Any good soap will suffice and the use of ether or other antiseptic soap is quite unnecessary He is then clad in a sterile gown mask and cap The sleeves end in elastic cuffs which should reach easily with full play to the wrists, and the cap and mask cover the head and face so that only the eyes are unveiled Finally a pair of rubber gloves is drawn on to the hands All his assistants are similarly prepared Nurses not taking an active part but acting as *runners* for the sister are clad in sterile gowns with their heads veiled. The anæsthetist should wear a gown, cap and mask but these need not be sterile except for operations above the level of the clavicles

STERILISATION OF MATERIALS

A **Instruments** are to-day invariably made of stainless steel They are boiled in water for at least ten minutes or if they have previously been used for a septic case twenty minutes must be allowed After boiling they are placed on a sterile towel on the instrument table Any instrument which drops to the floor during the operation must be reboiled if needed again. After use all instruments are thoroughly scrubbed with a stiff brush special care being given to the serrations of forceps etc They are then boiled dried and replaced in the cabinet

B **Rubber Gloves** are more pleasant to wear if dry-sterilised but this can be done only with special care under low pressure sterilisation as otherwise the rubber perishes In case of doubt it is safer that they should be boiled

C **Swabs** are made of butter muslin and are made up in several ways *e.g* in small squares of 4 6 or 8 thicknesses and sewn together at the edges or in loosely packed balls Rolls of gauze and abdominal packs are made of similar material of different shapes and sizes to suit individual requirements Towels are either white green or red and are made of calico All abdominal packs should have black tapes attached for identification during operation and small swabs should be put up in packets of six or ten so that they can be easily counted and checked. All these materials are sterilised by high pressure steam sterilisation. Bowls trays and dishes are boiled in a special container

D **Ligature Materials** are either absorbable or non-absorbable The latter except for skin sutures which can be removed are permanently embedded in the tissues in which they may act as an irritant or as a nidus for the settlement and development of micro organisms but they all have the great advantage of being boilable The unabsorbable materials include silk, linen thread, silkworm gut Japanese synthetic gut fine wire and nylon

SILK AND LINEN THREAD of varying sizes are wound loosely on glass spools and sterilised by high pressure steam heat or by boiling after which they are stored in glass jars in a solution of biniodide or in spirit The spools should be boiled immediately before use

SILKWORM GUT is issued in three strengths and some manufacturers stain them with distinctive colours the strong violet the medium pink and the fine black. It is sterilised by boiling for at least five minutes immediately before use A cheaper variety is the synthetic brand which is always coloured green and which is not quite so strong as the natural variety it is however more pliable and so easier to manage The very fine black or ophthalmic silkworm gut is the best material for fine work *e.g.*, in the face or neck. It should invariably be used in preference to horsehair which no longer merits inclusion among suture materials being difficult to sterilise and so elastic that it cannot compare with fine silkworm gut

CATGUT is the absorbable ligature and suture material being made from the submucous layer of the sheep's small intestine *It has the* disadvantage of being ruined by boiling and yet its very origin demands a most highly efficient method of sterilisation It is probably true to

say that no completely safe method will ever be found, but the preparation of catgut has recently been subjected to very stringent regulations by the Ministry of Health, and there are many excellent brands on the market It is made in a number of thicknesses and by varying methods in preparation is graded as being absorbed by the tissues in ten, twenty or forty days It is put up for sale in sealed glass tubes which are immersed in spirit for fifteen minutes before use. Kangaroo tendon is rarely used and then for special purposes such as the reapposition of a fractured olecranon process It is prepared by similar methods to those used for catgut

PREPARATION OF THE PATIENT

Except in emergencies a patient should be admitted two days before operation This may be criticised as uneconomic and unnecessary and many patients will complain of the waste of a day in reality these twenty four hours spent in quiet rest and relaxation pay a handsome dividend in safety and freedom from complications.

The Skin.—*General*—The skin should be shaved the day before operation plenty of soap and hot water being used. For abdominal operations below the umbilicus the whole anterior abdominal wall must be shaved including the pubic region in those above the umbilicus shaving should be carried up to the nipple level The skin is then thoroughly washed dried with a sterile towel swabbed with acetone and alcohol successively to remove all moisture and fatty secretions and then painted with tincture of iodine picric acid or spirit according to the custom of the surgeon concerned Some people are hypersensitive to iodine and a blister may result, with much unnecessary pain while picric acid leaves a yellow stain for many weeks Ninety five per cent spirit is probably the most satisfactory for routine use During the war when alcohol was in short supply C.T.A.B (cetyl triammonium bromide) was extensively used. The whole area is now covered with a sterile towel held in place by a bandage Swabbing with alcohol is repeated just before the beginning of the operation.

Special—The above routine serves for all general operations but in certain special cases a more rigorous technique is required especially when the tissues to be operated upon are less well equipped to deal with infection and in which minor degrees of inflammation might have serious after-effects Bones and joints are in this category and operations upon them should be preceded by a seventy two-hour preparation In the limbs it is wise to shave their whole length and the full ritual of washing swabbing and protection is repeated upon each of the three days before operation

The Bowels.—*General*—These will need attention but except for operations on the colon and rectum drastic purgation is not only needless but actively harmful If the bowel action has been regular and normal an enema on the evening before operation is sufficient should however patients have been constipated before admission an aperient to which they are accustomed is given on the first night and an enema the following evening The routine use of strong purgatives in pre-operative preparation is to be deprecated

Special—In operations upon the rectum and colon a different problem has to be faced The structures concerned teem with bacteria and in certain operations (*e.g* fissure fistula hæmorrhoids) an incision must be made through heavily infected tissues into clean The lower bowel therefore must be made as nearly sterile as possible The procedure is as follows and to make it more clearly understood days are quoted —

Wednesday evening	A moderate aperient *e.g* cascara
Thursday morning	Fruit salts in warm water
evening	Soap and water enema
Friday morning	Rectal and colonic wash-outs
evening	
Saturday 9 A.M.	Operation

If operation is delayed until after 12 noon a simple enema is given at 8 A.M In addition the administration of sulphasuxidine sterilises the large bowel and has greatly reduced the dangers of operating upon the colon and rectum

Diet.—*General*—Just as the water balance is upset by drastic purgation so starvation interferes with normal metabolic equilibrium Patients need to be fed not starved before operation Provided the stomach is empty when the anaesthetic is commenced no harm can come to the patient from regular feeding For all operations therefore except those upon the stomach and colon normal diet will be continued up to the evening before operation If this is timed for the morning no breakfast is given but if in the afternoon a light breakfast should not be withheld For three hours preceding transfer to the theatre patients should be encouraged to suck slowly barley sugar

Special—In gastric cases it is wise to limit the diet to fluids only on the day before operation If pyloric obstruction is present if the stomach is unduly distended or if a foul-smelling vomit is occurring a tube should be passed and the stomach washed out This may have to be done either the day before or the morning of operation It is a distressing procedure and if feasible should be left until anæsthesia is established when the anæsthetist can introduce the tube and get his patient comfortably settled before the surgeon starts

In rectal and colonic operations diet must also be restricted in order to assist the clearance of the lower bowel The scheme below gives parallel days to those given above —

Wednesday	Normal diet
Thursday	Soft foods with small residue
Friday	Clear fluids
Saturday 9 A.M	Operation

Smoking and Alcohol.—Although patients may protest both smoking and the use of alcohol should be forbidden for twenty four hours before operation

Psychological Considerations.—To every patient even a doctor an operation is an alarming prospect Admission to a strange hospital ward or nursing home room a different bed new faces and the knowledge that in a few hours a frightening ordeal lies ahead hardly conduce to

a peaceful happy mind and a relaxed body Kindly sympathetic understanding of these things is needed patients minds must be put at ease their anxieties and fears relieved and their doubts as to a successful outcome allayed.

In this connection a full night s sleep before operation is so essential that no patient must be left to spend a restless and sleepless night. It is better to give a soporific as a routine e.g medinal (gr x) nembutal (gr iii) luminal (gr i) or a bromide mixture (cf p 159)

Special Methods.—A *Diabetic s* careful regime must inevitably be broken for several days and it is essential that steps be taken before operation to help the patient in (a) the pre-operative phase (b) the operation and anæsthetic period and (c) the days after operation until the normal regime of feeding has been re-established Decisions must be taken concerning the use or temporary withdrawal of insulin the administration of glucose rectally orally or intravenously further more the urine must be regularly checked for the presence of sugar acetone and diacetic acid throughout the period of anxiety

Blood Transfusion —Certain operations are of a nature or severity which make a subsequent blood transfusion a probability On the other hand, patients may have an unsuspected anæmia or be suffering from a recognised blood loss A routine blood count is obviously unnecessary but an efficient pre-operative examination should include an assessment of such possible blood deficiencies It may mean a difference between life and death to have had a patient blood grouped before operation

Chemotherapy —In a great many infective conditions chemo therapy will be started in the pre-operative period In addition sulpha diazine and penicillin may be most usefully employed as prophylactics. By their use an earlier surgical approach to joints fractures and severed nerves, which have previously been involved in sepsis, is made safer for a secondary operation such as arthrodesis re-alignment and plating of fractures and nerve suture

Premedication is a question to be considered from the point of view of anæsthetist surgeon and patient and not for the convenience of the first named only as is sometimes the case The usual alternatives are (1) atropin (gr $\frac{1}{100}$) alone or (2) combined with morphia (gr $\frac{1}{6}$) or (3) omnopon (gr $\frac{1}{3}$) with scopolamin (gr $\frac{1}{150}$)

THE OPERATION

The patient having been placed on the table is covered entirely with sterile towels so that only the actual operation area is exposed. As soon as the skin incision is made all bleeding points are picked up with forceps and ligated and the wound edges covered with hot packs which are fixed in place by towel clips The details of operative technique cannot be discussed here but certain general principles are worthy of emphasis No operation should be undertaken by any surgeon unless he is capable of meeting with skill and dexterity any complication however unforeseen that may occur The incision should be long enough to give adequate access All exposed parts not essential to the particular stage of the operation are to be covered with hot

moist packs Speed is always important but gentle handling is far more so and it must never be sacrificed to a flashy rapidity Clean cutting and gentle separation mark the good *surgeon, rough tearing* the beginner Bleeding should be reduced to a minimum and, whenever possible vessels picked up in artery forceps before division.

At the completion of the operation the wound is covered with generous layers of gauze and wool, the whole being firmly bandaged in place If no drainage has been necessary the dressing should be changed on the second day after which the wound is left undisturbed till the stiches are removed on the eighth or tenth day If a drainage tube should have been inserted, the dressings may become saturated with blood and serous discharge during the first twenty four hours in which case they should not be removed, but more layers of wool or cellulose tissue placed over them and an additional bandage applied. At the end of another twenty four hours the whole dressing must be removed and from then onwards redressing should be reduced to a minimum compatible with efficient after treatment The after dressings are of great importance and as much care is to be taken of the surgeon s hands and his instruments as at the operation. An undrained wound will give no anxiety but a drained one can be easily infected with secondary organisms and the resulting mixed infection may have serious effects The truth of this teaching has recently been emphasised by the Medical Research Council s memorandum on Hospital Infections. It has been more fully alluded to on p. 120

Many operation wounds need but little dressing and patients are more comfortable without bulky bandages especially in hot weather After thyroidectomy for example the first dressing is removed on the second day when the wound can be protected with a thin layer of gauze fixed with mastisol—a surgical glue Clean abdominal incisions may be supported after the sixth day by wide strips of elastoplast strapping

POST-OPERATIVE TREATMENT

From Theatre to Bed.—The ideal so rarely attained is for the bed to be brought into the theatre and the patient transferred direct from operating table to it Doors, corridors lifts and even beds are not built for such luxury and in this country hospitals thus designed probably do not reach double figures Nevertheless in future no hospital plan should be accepted unless such provision is made The commonest and the least necessary complication of all inhalation anæsthesia is some type of pulmonary lesion. Too little thought is given to this short though vital period of transfer of an unconscious patient from theatre to ward or room The lift is not in place with doors open ready the trolley porter is not immediately at hand the nurse is momentarily called away for last minute instructions or to fetch a towel or porringer and the patient waits in a draughty corridor A close observer will notice that while several blankets cover the body below only a bath towel separates the patient from a canvas stretcher and yet cold from below is as penetrating as that from above None of these things should happen but the fact remains that sometimes they do

Arrival in Room.—On return from the theatre the patient is placed in bed this having been heated during the operation by a radiant-heat cradle. The windows in its immediate vicinity must be closed and especially no cross-draughts between them and the door allowed. The desire for fresh air in surgical wards is sometimes the actual cause of broncho-pneumonia and other post-anæsthetic pulmonary lesions While still under the influence of the anæsthetic the patient is placed on one side with knees drawn up and head kept low in order to prevent any vomitus or secretion trickling down into the trachea He is wrapped in a blanket covered with the usual bed-clothes and kept warm with hot-water bottles applied *outside* the blanket He is not to be left alone for a moment until full consciousness has been regained, when he can be moved into the position demanded by the particular requirements of the operation

Shock will be treated by the methods laid down in Chap VIII

Relief of Pain.—Few operations however small are unaccompanied by some pain and in all those performed on the abdominal contents bones and joints thorax and neck pain will be considerable No patient should be allowed to suffer pain unnecessarily and equally no drug should be given needlessly Some patients will suffer severe pain stoically without a complaint, while others will behave as if a minor ache were a major disaster It is one of the more important of the student s early lessons to be able to distinguish these two types. As soon as the effects of the anæsthetic and premedication have worn off a hypodermic injection of morphia (gr ¼) omnopon (gr ⅓) or heroin (gr ⅙) will be needed and a second dose should be given six to eight hours later The need for further opiates will depend upon the type and severity of operation but the ideal is to discontinue these drugs as soon as possible in favour of other less powerful analgesics and sedatives.

Feeding.—*General* —There will be no desire for food for the first thirty six to forty-eight hours and no effort should be made to force food upon an unwilling patient who can comfortably exist on small drinks of water at frequent intervals After this a start is made with soups jellies lightly boiled eggs, thin bread and butter tea or coffee and within one or two more days full diet will again be taken

Special —After partial gastrectomy a more rigid technique is observed The original Moynihan regime was as follows —

Twelve-hour Periods.	B Mouth	R Rectum.
1	½ oz. distilled water hourly	One pint of glucose saline every six hours.
2	1 "	
3	1½	
4	2 "	
5	2½	
6	3	
7	3½ "	
8	4	
9	4½	
10	"	
11	½ "	
12	6 "	

An enema each alternate evening for the first six days is followed by an aperient on the sixth night

Seventh to thirteenth day 4 pints of citrated milk in three-hourly feeds over twenty four hours Thin wafer bread and butter

Fourteenth day onward steamed fish puree foods until normal diet has been reached

This regime is considered unnecessarily strict by many surgeons who will order citrated milk on the fourth day

Small intestinal resections need no special restrictions

Rectal and colonic operations require to be described under two separate headings If a colostomy has been performed upon a previous occasion no restriction in diet is needed. If no colostomy exists patients must be kept on clear fluids for three days and then gradually resume normal feeding

Bowel Action.—*General* —In ordinary cases in which there has been no interference with the intestinal canal and there is no fear of peritonitis a simple enema should be given on the evening of the day following operation and repeated the next day On the third evening an aperient is administered and a saline draught in hot water given the next morning A good action should result, but it must be remembered that after operation the bowel will not respond to a normally efficacious dose in fact in many patients it is kinder to give castor oil in spite of its unpleasant taste and sinister reputation

Special —For gastrectomy patients bowel management has been described above for small intestinal resections the general plan is applicable

After resections of the colon and in the absence of a colostomy enemata should not be given in order to avoid tension on the suture line A flatus tube should be passed to control distension and if absolutely necessary a small glycerin enema may be administered On the sixth morning a fluid motion may be obtained by giving magnesium sulphate in drachm doses hourly up to six hours or until an action has occurred

In operations upon the lower rectum the first evacuation is likely to be very painful and patients must be helped over this difficult moment No action is permitted for three days following operation and any tendency must be suppressed by doses of tincture of morphia and kaolin On the fourth morning a dose of castor oil is followed by a glycerin enema about one hour before an action is expected. When this appears imminent a suppository containing cocaine (gr i) is inserted.

Abdominal Distension in minor degrees is inevitable in every abdominal operation if a source of pain it can be easily dissipated by a simple enema Distension however is a sign which *must* be most carefully watched since it may be due to acute dilatation of the stomach or a threatened ileus (*q v*)

Smoking should be forbidden for forty-eight hours in straight forward cases Alcohol should be withheld for a similar period, after which there is no objection to its use and patients accustomed

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6	3 " " "	
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8	4 " " "	
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Smoking should be forbidden for forty-eight hours in straight forward cases Alcohol should be withheld for a similar period, after which there is no objection to its use and patients accustomed

to partake regularly and somewhat liberally may suffer from its absence

Confinement to Bed.—A great deal of needless suffering weakness and muscular atony are due to keeping a patient too long in bed, and to a rigid restriction of movement in the early days From the second day every patient is to be encouraged to move about in bed assist in the bed making and in the rites of bed pan and blanket bath After an uncomplicated operation it is becoming the custom to allow early ambulation with a view to reducing the incidence of post-operative venous thrombosis This cannot apply to those operations for the repair of hernia which require eighteen days for their after-care as well as certain procedures which leave considerable raw areas to granulate (*e.g* fistula-in-ano) If the finances of the patient allow massage of the lower and upper extremities should be given from the third day onwards

Breathing Exercises and Muscle Drill.—In recent years in the surgical wards at St Mary s Hospital in addition to treating individuals we have instituted a twice-daily drill for every occupant except those certified each morning by the house surgeon as unfit A member of the physiotherapeutic department is in charge and all exercises are done in unison and by numbers The exercises include deep breathing *rhythmical movements of both extremities quadriceps drill etc* By these methods pulmonary complications have definitely decreased and that most terrible of all post-operative disasters namely pulmonary embolism should become a thing of the past. Suffice it to add that this regime starting under a cloud of suspicion, has become popular both with the nursing staff and patients

R M. HANDFIELD-JONES.

CHAPTER XI

CHEMOTHERAPY

SINCE the time less than a century ago that Pasteur discovered that living bacteria were responsible for the majority of human infections the search for the ideal antibiotic—the substance that would kill living pathogenic organisms without detrimental effect on the patient or his tissues—has gone ceaselessly on Later in the last century introduced the methods of antisepsis—methods which are still to a limited degree in use to-day although to a great extent in surgery replaced by their obvious corollary—asepsis i.e. the prevention of bacterial entry rather than the treatment of an established invasion (see p 182)

It is fair to say that despite the hundreds of substances investigated no foolproof antiseptic has yet been discovered Any substance which in itself is so potent or can be so concentrated as to guarantee a 100 per cent bactericidal effect *in vitro* has always proved to be so harmful to living tissues that its use *in vivo* is to a large extent precluded and despite the undoubted value of and steady improvement in aseptic methods it is only too well known that infections do still occur either before during or after surgical treatment

During the last twelve years two great advances have been made by those treading this thorny path The first was the discovery and development of the *sulphonamide* group of drugs the second the discovery and application to clinical medicine of *penicillin* and subsequently *streptomycin aureomycin* and other *antibiotics* The use of these two groups of substances—sulphonamides and antibiotics—to-day comprises the subject of Chemotherapy It should be borne in mind that none of these are in themselves completely satisfactory anti bacterial defences—the crusade for the Holy Grail of the perfect antibiotic still goes on! Both the sulphonamides and the antibiotics are unfortunately selective in their action and even between them they still leave big gaps The great advantage of the latter over the former is that whilst the antibiotics are relatively innocuous to human tissues i e overdosage is impossible the sulphonamides all have variable but definite toxic effects on the body as a whole and on some of its specialised cells in particular Thus to a large extent antibiotic therapy has replaced the use of the sulphonamides but there still remain fields where the latter hold undisputed sway and others where a combination of effects produces better results than those achieved by either alone These relative differences will be dealt with later

In the first place it is essential to stress two points —

(i) Any and all chemotherapeutic agents are but the handmaidens of good surgery they do not replace it No amount of

penicillin however vast will buy a dispensation for the sins of faulty surgical technique

(ii) If really constructive and progressive results are to be forthcoming from the use of these invaluable substances, bacteriological research and meticulous control must go hand in hand with clinical experimentation and observation

Given these two desiderata it is possible to foresee a great and stimulating development in the field of chemotherapy in the not too distant future

THE SULPHONAMIDES

It is hard to realise that it is not much more than ten years ago since the first sulphonamide drug was used therapeutically This was prontosil which in 1935 Domagk used to treat various cases of streptococcal infection His work was largely experimental and empirical, as the drug had proved quite inactive *in vitro* But the clinical results from this sulphonamide-containing azo-dye were so satisfactory that progress in this field of chemotherapy has never stopped since The original drug was soon followed by prontosil rubrum and a form which could be used parenterally prontosil soluble In rapid succession followed rubiazol proseptasine soluseptasine uleron albucid and a host of others

The outbreak of war in 1939 gave fresh impetus to the use of these drugs, which was a vital factor in the first years in controlling sepsis in war wounds In fact, the surgery of the last war has been well divided into the pre-sulphonamide the sulphonamide and the penicillin eras In the first general and local infections were as rife as in the first world war In the second, generalised spread of infection was largely controlled but local sepsis in wounds was still almost universal In the third, both local and general bacterial effects were cut to a very minor degree

During the last five years a large number of these drugs—the group name of which is the Sulphonamides—has been produced, and many of them have been sufficiently valuable in producing practical clinical results to remain in current use It is this complexity of types which makes the subject somewhat difficult to summarise

ACTION, PROPERTIES, PHARMACOLOGY AND ADMINISTRATION

The sulphonamides are essentially bacteriostatic In bactericidal dosage they are lethal to normal tissue cells especially those of the blood This fluctuating but relatively narrow margin of safety between bacteriostasis and toxicity is the factor that has stimulated the constant production of more and more varieties in an attempt to find a product the anti bacterial potency of which is not vitiated by its toxicity

There seem good reason to believe that the sulphonamides as a group act by preventing sensitive bacteria from using the *p*-amino benzoic acid which forms the essential part of a complex enzyme system

on which the organisms depend for their growth The sulphonamides are supplied as powders tablets or solutions and the powder can be incorporated in ointments or creams As a group they are relatively insoluble in water They act better in an alkaline medium and this fact together with their tendency to reduce the CO_2 combining power of the blood (i.e to produce an acidosis) makes it advisable to prescribe them with some alkaline mixture

They are absorbed readily from the intestinal tract (with marked exceptions e.g sulphasuxidine) and appear in maximum con centration in the blood within about three to four hours In the absence of further dosage this concentration will steadily fall over the next twenty four hours, although traces can usually be found up to three to four days To maintain a steady blood concentration therefore dosage must be repeated at intervals of approximately four to six hours and may be continued according to the individual sensitivity of the patient (see complications) and the clinical effect on the disease concerned for a week or ten days The sulphonamides appear in all tissue fluids and secretions (milk saliva cerebrospinal fluid amniotic fluid etc) but chiefly in the urine—this being the main route of excretion They can be administered parenterally but apart from a slight hastening of absorption these routes have no advantages over the oral method—which is the one of choice i e they are usually given as tablets by mouth They can be and are widely used locally for surface application although their absorption from raw surfaces (e.g wounds and burns) is so much more rapid that care must be taken to avoid such overdosage as gives toxic symptoms Their action in cavities especially septic cavities is more limited and with one exception (marfanil) they are inactivated by the presence of pus i e they have no therapeutic value in an abscess In this respect their action must take second place to penicillin (q v) as is also the case in regard to the actual number of bacteria being attacked. With penicillin this is of no concern with the sulphonamides the fewer the bacteria being attacked the greater the bacteriostatic effect so that the sulphonamides can be swamped by a massive intense infection

As a generalisation it may be said that the sulphonamides exert their action chiefly against two large groups of bacteria—the common cocci (streptococci more than staphylococci, pneumococci gonococci and meningococci) and the intestinal flora (the *B coli* group *B dysenteriæ* enterococci and to a selective extent the gas forming organisms)

VARIETIES

It is impossible to give a complete list of these here For further details recent textbooks of pharmacology and medicine should be consulted Only those with a more general or particularly surgical application are mentioned below

1 **Sulphanilamide**, the active principle of the original prontosil still is over the whole therapeutic field (including local uses and its application as a vehicle for penicillin) the most widely used of the sulphonamides It is relatively one of the more soluble sulphonamides

and its toxicity is only moderate It probably finds its chief usefulness in local applications and in prophylaxis both local and general.

2 **Sulphapyridine** (M & B 693) is amongst the most insoluble of the sulphonamides and is therefore of little use in parenteral therapy Its efficacy is certainly greater than that of sulphanilamide but so also are its toxic effects For this reason it has largely been replaced by other members of the group

3 **Sulphathiazole** is undoubtedly still amongst the favourites. With a high therapeutic efficiency a relatively good solubility and a low toxicity it has developed a wide field of applications Its crystals are finer than most of the other members of the group and as it therefore presents a relatively larger surface area it is more rapidly absorbed. It is a more potent bacteriostatic and affects a wider range of organisms than sulphanilamide. It is for instance one of two sulphonamides to affect the gas-forming organisms and its therapeutic effects in such widespread infections as gonorrhoea and impetigo are particularly good. It is specifically contraindicated for application to the surface of the brain

4 **Sulphadiazine.**—The chief competitor of sulphathiazole in the therapeutic field It is less soluble but is equally potent and if anything less toxic Few renal complications have been reported after its use and it is the sulphonamide of choice for local cerebral application Because of its slower and less complete absorption and because its excretion is also slow it is possible to maintain an effective blood concentration with smaller doses of this drug than probably any other in common use

5 and 6 **Sulphamerazine and Sulphamethazine** (S, mezathine) are two relative newcomers with much promise Their absorption rate is higher than that of sulphadiazine but they are excreted slowly and hence relatively low dosage can produce satisfactory blood concentrations Sulphamerazine has a potency equal to that of sulphadiazine but its toxicity is also similar Sulphamethazine on the other hand though only of a potency comparable to sulphapyridine is much less toxic than most of the sulphonamides It now finds a wide field in intravenous use Both of these compounds have to some extent displaced the older favourites.

7 **Marfanil**, the actual formula of which is 4-amino methylbenzene-sulphonamide is not well known in this country but was the chief sulphonamide of the German Army and was in the last stages of the campaign used by our medical officers to very good effect—especially as a local application It has two outstanding features, apart from a satisfactory non-toxicity of acting in the presence of pus (unlike any other sulphonamide) and of being effective against infections due to gas-forming organisms

8 9 and 10 **Sulphaguanidine, Sulphasuxidine** (Succinylsulphathiazole) **and Sulphathalidine**—These three sulphonamides have a specific field of activity against the intestinal flora as they are absorbed to minimal extents only (sulphasuxidine only 5 per cent) They are therefore to all intents and purposes non toxic and can be given in large doses. The use of sulphaguanidine revolutionised the treatment of bacillary

dysentery during the war In passing it should be noted that sulphapyridine has equally lethal effects on the dysentery bacilli but its far greater toxicity precludes its use in the majority of cases Sulphasuxidine which in contact with the tissues slowly frees sulphathiazole is used both in freeing the gut of pathogenic organisms before and after colon surgery and also as a cream on wounds and burns

USES AND DOSAGE

From the above brief descriptions it will be appreciated how difficult is the choice of any particular sulphonamide for any individual case The use of one drug rather than another will depend on many factors—the infection concerned and its intensity the patient s susceptibility to the causal organism and to the sulphonamides and his general condition the surgeon s experience etc The aim of treatment with these drugs is to establish as soon as possible and to maintain as long as necessary a bacteriostatic blood sulphonamide level which is such that it is sufficient to control bacterial multiplication without endangering the body s *natural resistance mechanisms (e.g the leucocytes)* or his normal tissue cells

The **prophylactic** use of the sulphonamides has developed greatly in recent years but the field is still capable of vast extension Locally sulphonamide powders are applied to most suspicious wounds to-day —and to many burns As a guide it may be said that 10 grm is the maximum safe application to any one raw area and 15 grm to any one patient Generally much research is still going on into the protective effect of long-continued small dosage The routine general prophylaxis in the Army was approximately 20 grm over four days the drug being given in tablet form The sulphonamides have been used prophylactically in such widely varying conditions as an outbreak of scarlet fever as a protective against gonococcal infection in connection with colon and renal surgery and to ward off possible post operative chest complications

The **therapeutic** uses are of course legion and are dictated simply by the nature of the causal organism and to-day by the competition of the non toxic penicillin The sulphonamides still have a monopoly in diseases due to the intestinal bacteria (and what might be called their primary fields therefore lie in the surgery of the intestinal and renal tracts) but as they are in no way antagonistic it is still common practice for both penicillin and sulphonamides to be used in severe infections when the causal organism is sensitive to both Again as a generalisation a total dosage of 40 to 50 grm is in most cases as much as can safely be given

SENSITIVITY AND RESISTANCE

These are two important factors in sulphonamide therapy Experience has amply proved that certain patients are abnormally sensitive to any of these drugs and in such their exhibition is definitely dangerous Toxic symptoms are pronounced and the result can in the worst cases be fatal.

On the other hand, patients can possess or develop a resistance to the sulphonamides This resistance has been classified as —

(a) **Acquired,** usually due to an initial inadequacy of dosage.
(b) **Relative,** in which by simply increasing what may be called the normal dosage good results are obtained
(c) **Absolute,** in which the drugs have no effect at all

Some of the reasons put forward for relative and absolute resistance are either too slow absorption or too rapid excretion of the drug giving a blood-sulphonamide level that is ineffectual indifferent natural responses i e positive bacteriostasis but little complimentary leucocytic reaction and impaired access of the drug—an impoverished blood supply not taking the drug to the site of infection It is with many of these resistant cases that penicillin enters one of its more useful fields

REACTIONS AND COMPLICATIONS

Seldom is a sulphonamide drug administered in therapeutic dosage without the patient showing some reaction Admittedly in the majority the signs and symptoms of this are mild and transient But unfortunately in a definite percentage the complications are serious and may even be fatal

Amongst the minor symptoms experienced by patients under treatment with sulphonamides are headaches vertigo anorexia, nausea a slight fever some dyspnœa and tachycardia and almost universally (80 per cent) a distinct pallor (to which is often added a cyanotic tinge) and a subjective feeling of mental depression

The more serious complications include skin eruptions (erythematous papules vesiculation and pustules—all of which tend ultimately to desquamate) hæmolytic anæmia and jaundice hæmaturia and anuria and rarely optic and peripheral neuritis

PENICILLIN

Penicillin is an antibiotic substance produced in culture of the mould *Penicillium notatum* Its exact constituents are not yet know and it has not yet been successfully synthesised but as a result of recent research it has been concentrated and purified to over 90 per cent The penicillin used during the last war a powder coloured yellow by impurities was at best only 50 per cent pure

Penicillin was discovered by Sir Alexander Fleming of St Mary's Hospital in 1928 when a chance contamination of a staphylococcus culture plate led him to investigate the antibacterial powers of the causative mould At this time he found that penicillin was not only inhibitory to certain bacteria in varying degree (bacteriostatic) but also in sufficient concentration bactericidal He also proved that although three times a potent as carbolic acid penicillin was entirely without detrimental effect on leucocytes The discovery then lay fallow until Florey Chain and their team of workers at Oxford developed the possibilities some ten years later and finally in 1941 used penicillin

therapeutically on human patients with encouraging results Owing to the war production in this country was at that time difficult but Florey visited America enlisted practical assistance and ensured the delivery of increasingly large quantities of penicillin during the vital war years of 1944-45 The bulk of the early therapeutic work was done in connection with Service patients and the first mass prophylactic employment of penicillin was carried out in the invasion of Normandy and the subsequent campaigns Now that supplies are readily available in this country it is essential that this invaluable substance should be properly used and that its field of usefulness which though wide has definite limitations should be properly understood A brief account will therefore be given of its properties action administration and uses For more complete details recent textbooks dealing exclusively with this subject should be consulted

PROPERTIES OF PENICILLIN

Penicillin is produced from a culture of *P notatum* a great variety of media having been used industrially in the process The mould requires a good supply of oxygen and grows more luxuriantly when on the surface of a shallow layer of fluid In the underlying fluid is the crude penicillin which when extracted and concentrated appears as a yellowish powder This powder is the calcium or sodium salt of penicillin and is acid in reaction The colour is due to impurities most industrial penicillin still being only approximately 50 per cent pure at the best The sodium salt being very deliquescent absorbs moisture rapidly and thereby deteriorates quickly The calcium salt is relatively more stable but in solution there is little to choose between the stability of the two salts

(i) They are stable in solution only between pH 5 and pH 7 (*i e* approximate neutrality) For this reason the giving of penicillin in glucose-saline solution—which is often definitely acid—should be discontinued As much as 60 per cent of the potency of penicillin can be lost at room temperature within twenty four hours if this solution is used as a diluent Penicillin is in fact rapidly destroyed by all acids and alkalis

(ii) Boiling or excessive heat is also lethal to penicillin Sterilisation by these means is therefore impracticable Powders if kept dry will retain their potency for many months if stored at room temperature but solutions (and to a greater extent ointments) are not trustworthy after a week s storage unless kept in a refrigerator when little deterioration seems to take place even over a period of several months

(iii) Penicillin is very sensitive to the effects of heavy metals alcohols and oxidi ing agents Therefore in using it any preliminary skin cleansing must be done with saline or simple soap and water only It is probably because of this sensitivity that many forms of synthetic rubber exert a rapidly detrimental effect on penicillin potency Some glassware i similarly noxious

(iv) Penicillin is freely soluble in water and in solution diffuses rapidly *e.g* on an agar plate

(v) It is destroyed by many bacterial enzymes e.g those of *B coli* and thus points to the vital necessity of efficient sterilisation of all vehicles used in its administration and to the strict avoidance of contamination in preparation and storage These enzymes are termed penicillinases

(vi) Some further points of practical interest in connection with the stability of penicillin are that the deterioration of potency varies considerably according to the vehicle used in industrial preparation of the powders e.g over a period of six months and storage at room temperature penicillin made up with sulphonilamide or dried plasma retained full potency that with sulphathiazole or proflavine had steadily deteriorated to almost 50 per cent of its original value Again, whilst percaine decicaine and 1 200 000 adrenaline have little effect on penicillin potency procaine, cocaine and novutox produce increasing degrees of deterioration—a point of practical importance in the use of local anæsthetics in administration

PHARMACOLOGY

In the body penicillin is rapidly absorbed after parenteral administration a maximum blood concentration being obtained within fifteen minutes of intramuscular injection It is equally rapidly excreted by the kidneys although small amounts can be found in sputum bile and saliva. Taken by mouth it is destroyed by the acid of the stomach introduced rectally the penicillinase of the colon bacteria rapidly negative its effects There is slight absorption from the buccal mucous membrane fairly rapid absorption from the peritoneum and much slower from other serous cavities (pleura pericardium synovia of joints) and cerebrospinal spaces Conversely parenteral administration allows only slow diffusion into these cavities from the blood stream although there is some evidence that in inflammation of these serous *membranes permeability is to some extent increased.*

Again, it should be remembered that where a blood supply is defective penicillin will not be able to exert any effect. Thus it can have no action on sloughs sequestra or gangrenous tissue in general nor can it permeate into an established abscess cavity The practical therapeutic importance of these facts is obvious

ACTION

The precise method of action is not yet known Penicillin is selective in its action on bacteria (see table p 201) some being highly sensitive to a dilution of 1 100 000 000 or more some less so some not at all This sensitivity varies not only from species to species but actually within any one species Again an organism at first sensitive to penicillin may develop resistance to it particularly if dosage is inadequate It is doubtful however if any organism originally completely sensitive ever becomes completely resistant and it is comforting to know that organisms which show increased resistance also suffer a proportionate loss of virulence The action is essentially antibacterial

as against antitoxic At first it was thought therapeutically to be simply bacteriostatic i.e holding up the multiplication of organisms until such time as the body's local defence mechanism could cope with the infection Now it is amply realised that in sufficient dosage and concentration it is actually bactericidal However heavy the infection penicillin is not inhibited—unlike the sulphonamides Furthermore it acts in the presence of pus (a property possessed by only one of the sulphonamides—marfanil) and has no deleterious effects on the body's natural leucocytic response on any normal tissue cells or on the processes of repair and healing

In the early days of penicillin it was thought that neither blood nor serum had any effect on penicillin potency but more recent work has proved that at body temperature serum has a progressively inhibiting effect on penicillin—this effect is completely negatived by refrigeration With present methods of administration in which the blood penicillin level is kept at consistently high figures this fact probably has little practical significance but in its local use it may well have a definite bearing

The following table shows the sensitivity of various organisms to penicillin —

Sensitive	Insensitive
Staphylococcus aureus.	*B pestis.*
Streptococcus haemolyticus.	Enterococcus.
Streptococcus viridans.	*B pyocyaneus.*
Meningococcus.	*B. proteus.*
Gonococcus.	*B coli.*
Pneumococcus.	*B. typhosus.*
Clostridia of gas gangrene	*B. paratyphosus.*
B diphtheriae *B welchii*	*B. dysenteriae.*
Diphtheroids. *V septique.*	*V cholera.*
M catarrhalis. *B. oedematiens.*	*B tuberculosis.*
B. anthracis.	*Brucella abortus.*
Treponema pallidum.	*Brucella melitensis.*
Actinomyces.	*B. friedländer*
B tetani	Viruses (most).
Sarcina.	*B. pertussis.*
B. morax axenfeld	Yeast and moulds.
Leptospira icterohaemorrhagica.	Protozoa

It should be stressed again that this table is neither complete nor absolute It simply serves as a basis for practical penicillin therapy

ADMINISTRATION

Supply —Penicillin is supplied as —

1 *Powder* the original industrial concentrate carried in a vehicle which is usually at present one of the sulphonamides—or dried plasma

2 *Solution* the powder dissolved in sterile distilled water normal (isotonic) saline etc

3 *Ointments* or *Creams* the powder made up with oils vaseline lanette wax etc.

4 *Tablets* a more slowly soluble form of the powder
5 *Lozenges* for oral and dental use—powder and gelatine
6 *Lamillæ* for ophthalmic use

The stability of these various products has been mentioned above. Generally speaking they should in order to retain their potency for the maximum time be kept dry and at low temperatures

Dosage.—The unit of dosage is at the moment quite empirical. It is an arbitrary potency unit—the measure of the capacity of penicillin to inhibit the growth of a definite strain of staphylococci As this organism was growing in an Oxford laboratory where the research work was being done it is known as the Oxford Unit. The Oxford unit is therefore the minimal amount of penicillin in 50 ml of medium that will completely inhibit the growth of the Oxford staphylococcus. Because in therapy such large quantities can be and are given another standard measurement has come into everyday use —the megaunit a million Oxford units.

The standardisation of dosage both in manufacture and in therapy is still far from stable and probably will remain so until pure synthetic penicillin can be made and administered in dosages of so many milligrammes

But in order to give some idea of the use of this potency unit, approximate figures for the penicillin content of the above-mentioned supplies may be given The powder will contain for example 5 000 units of penicillin per gramme of sulphonamide the cream 500 units per gramme of wax, the tablets anything from 5 000 to 10 000 units each Again, purely as a guide it may be stated that the average daily dose of parenteral penicillin will be in the neighbourhood of 100 000 units This, of course will vary widely with the nature of the infection and its intensity the condition of the patient the stage of the disease the method of administration etc The figure is simply given as a rough indication of the dosage in present-day therapy and the use of the unit dosage

It is impossible to give an overdose of penicillin. A certain maximum blood level is rapidly reached in any individual after which further increase of dosage simply leads to increased rate of excretion The questions as to where is the dividing line between a bacteriostatic and a bactericidal level whether there is an optimum rather than a maximum blood level, whether intermittent or continuous administration produces the better results whether massive solitary doses or a few large doses given at short intervals will effect the same answer as more protracted administration whether it is possible by some means to retard the excretion of penicillin and obviate the high dosage—these and many other questions still await a definite answer But it should be remembered that penicillin therapy is still virtually in its infancy and that only very recently have production and supplies been generally available At the present time it is fair to say that the less frequent the doses the larger they must be to produce practical results—and that the less frequent larger doses are far less economical It is hoped that before long this latter factor will be only of relative importance

Methods—The aim of administration is to get the penicillin into contact with the sensitive bacteria This can be achieved either —

(a) *Directly* by local applications in powders sprays ointments etc or by injection of solutions into serous cavities abscesses etc or

(b) *Indirectly* by the blood stream following intravenous intra muscular or subcutaneous injections of a penicillin solution Such injections may be (i) intermittent (ii) continuous

A LOCAL—1 *Powders*—These are applied by an efficient insufflator or by shaking through sterile gauze (frosting) They are used chiefly for treating open wounds The average amount required for a moderate-sized wound would be about 2 grm of the vehicle (sulphonamide or dried plasma) containing approximately 5 000 units of penicillin A weaker powder containing 500 units per gm is favoured for burns and certain skin conditions

2 *Solutions* of a strength of about 500 units per c c may be instilled into wounds sprayed on to skin or throat while a stronger concentration (5 000 units per c c) can be injected into the pleural cavity meningeal spaces abscesses or joints The quantity injected will vary according to the size of the cavity and the intensity of the infection—something between 1 and 10 c c being an average

3 *Creams* usually made up with lanette wax (SX) and oils contain 500 units per grm They are applied by a sterile spreader and used for burns superficial wounds skin diseases etc Usually two to three applications daily are required

4 *Pastilles* with a gelatin or agar base and each containing 500 units of penicillin are used in infective conditions of the mouth teeth gums and throat They should be allowed to dissolve slowly and not chewed or sucked They should each last approximately two hours

5 *Lamellæ* for use in superficial eye infections Many ophthalmologists still prefer a solution powder or ointment as a local application

B SYSTEMIC (Parenteral)

1 *Intermittent Injections*—1 to 2 c c of penicillin solution containing an average of 15 000 to 20 000 units (this may be greatly increased of course wherever necessary) are injected every three to four hours intramuscularly into the buttock the outer aspect of the thigh or the pectoral region This method ensures an adequate though fluctuating concentration in the blood, but the frequency of the injections entails considerable disturbance of the (frequently very ill) patient and constant attention from the medical and nursing staff Usually a patient will tolerate two or three days of intermittent injections reasonably well, but after that in a large percentage relative or actual needle shyness develops The pain of penicillin injections varies greatly from patient to patient and is dependent on a number of factors *e g* the site of injection the rate of injection the quantity of fluid used the particular brand of penicillin the skill of the giver the sharpness of the needle and the general condition of the patient both physical and mental

2 *Continuous Intramuscular Drip*—In administration over a period of more than two to three days this is certainly the method of choice It demands a considerable amount of attention from the medical staff but well trained personnel soon learn to reduce this to the minimum and the patients undoubtedly prefer it Certain ingenious pieces of apparatus have already been evolved to make the method foolproof but a well placed needle connected through a drip-chamber to a container of penicillin solution will after initial careful adjustment, give surprisingly little trouble

The needle is best placed slightly obliquely into (preferably) the *vastus lateralis* through carefully prepared skin The needle should be about 3 in long and, after insertion should be fixed by strapping, etc. (A very sound practical method is to insert the needle first through a small piece of sterile rubber tubing and strap this latter to the skin) No further splinting is required though the patient should be warned that excessive movement may give pain. The method is obviously inapplicable to very restless or delirious patients. The site of injection is better changed every two to three days in protracted administration. It will be found that the majority of patients are sufficiently intelligent, interested and co-operative to assist in drip control at any rate during their waking hours.

Approximately a pint of fluid—saline should be used in preference to either distilled water or glucose saline as the former tends to give pain and the latter to destroy the penicillin—containing 100 000 to 120 000 units is given over twenty four hours. This entails a drip rate of 7 to 8 drops per minute

3 *Intravenous*—Penicillin can be given intravenously (with blood serum or saline) but its impurities contain thrombogens and are likely to produce thrombophlebitis in superficial veins

If this route is indicated (severity of infection, etc.) the best method is to inject the penicillin solution at intervals into the rubber tubing leading from the container to the intravenous needle and deliberately to accelerate the flow of whatever fluid is being administered for half a minute before during and after the insertion of the penicillin Using this technique thrombosis rarely occurs

4 *Subcutaneous*—Absorption by this route tends to be slow and irregular and the risk of cellulitis is undoubtedly greater than injection into more vascular muscle tissue This approach is therefore seldom used.

Finally mention should be made of three further methods of administration at present still on trial —

C INTENSIVE THERAPY —Where anything from 10 000 to 60 000 units are injected intramuscularly through a needle left *in situ* at intervals of ten to fifteen minutes for one and a half to two and a half hours This method has found some success in treating venereal disease and has produced dramatic results in the cure of carbuncles in a phenomenally short period of time

D SLOW RELEASE VEHICLES —In this type of administration the object is to administer one massive dose of penicillin in a vehicle which

will delay its absorption (e.g. some oily base) over a reasonable period. By far the most commonly used of these is *procaine penicillin* (with or without aluminium monostearate). This depôt preparation can be given in either aqueous or oily suspension by the use of which a daily dose of 600 000 or 300 000 units respectively will produce a minimum twenty four hours therapeutic blood penicillin level.

b. INTERRUPTED COURSES.—Bigger has suggested that two to three courses of relatively intensive therapy should be given at intervals of three to five days in order to pick up stragglers. Recent work suggests that a method of this sort is sound in practice.

DURATION OF TREATMENT

The use of the word "course" brings up the question of duration of treatment. There is essentially no such thing as a "course" of penicillin therapy. The drug is administered for as long as it is required to give clinical results—or until it fails to do so. If the aim has been prophylaxis and no untoward symptoms have developed in the interim three to four days are usually sufficient. Therapeutically the time of administration will vary with the sensibility of the causal organism, the intensity of the bacterial attack and the adequacy of the dosage. Wherever possible laboratory control should be used to assess a "cure", but clinically a general improvement in the patient's condition (fall of pulse rate and temperature, ability to sleep, absence of pain, return of appetite, etc.) and an amelioration in the local signs of the infection point to a satisfactory outcome. If clinical grounds only are being used to assess cure the administration of penicillin should be continued for three to four days after the disappearance of symptoms and signs. Within these limits it will be seen that penicillin administration may extend over periods varying from two or three days to two or three weeks.

REACTIONS, SENSITIVITY AND RESISTANCE

Penicillin is virtually non toxic. There are no known contra-indications to its use, overdosage is impossible and it can be combined safely and satisfactorily with many other drugs (e.g. the sulphonamides). Such reactions as do occur can usually be ascribed to the impurities in the powder as at present commercially supplied—or occasionally to faulty technique. But its widespread (and sometimes rather thoughtless) use over the past few years has proved that there is a very small percentage of people (about two to three per 10 000) genuinely sensitive to purer forms of penicillin. This allergic response, which occurs typically *in seven to ten days* but may appear in a few hours or after three to four weeks, clinically resembles serum sickness, etc., *manifested* by urticaria and generalised pruritus, pains in and swelling of joints, muscle pain, enlargement of lymph gland, rapid pulse and pyrexia.

Sensitivity is treated by the suspension of penicillin therapy and by the exhibition of one of the antihistaminic drugs, e.g. benadryl (50 mg t.d.s.), anthisan, phenergan, etc. Sensitivity may disappear spontaneously or, if necessary, desensitisation may be carried out.

Local reactions include pain stiffness thrombophlebitis fixation abscesses and a transient urticaria or dermatitis An irritant effect in serous cavities is not uncommon and in high concentration the nervous system (*e g* the theca) is directly affected Some degree of pyrexia is often seen usually some days after the initial fever due to the infection has abated. This is almost certainly due to pyrogens in the impurities of the powder

Failure of penicillin treatment apart from its use against insensitive bacteria, *i e* without good laboratory control can usually be ascribed to inadequate or infrequent dosage to lack of potency in the particular brand being used or to the focus of infection being inaccessible to the drug owing to defective blood supply to the part concerned. Evidence has accumulated however to show that indiscriminate use of penicillin does produce penicillin resistant and penicillinase producing types of organisms particularly staphylococci

USES

Clinical applications are legion—and are still increasing daily It is impossible here to do more than summarise the indications and further details will be found under relevant headings in many other parts of this book. At its inception and until quite recently penicillin was used entirely as a therapeutic agent as has been mentioned earlier its first large-scale prophylactic use was in the closing stages of the last war Whereas it seems likely that the majority of therapeutic fields have already been well explored and that advances will come more in the development of technique and methods of administration than in the discovery of any new spheres of activity there is no doubt that great possibilities still await the result of research into the prophylactic potentialities of penicillin

A **Prophylactic.**—In the final stages of the last war penicillin prophylaxis became a routine in all seriously wounded cases The relative disappearance of the previously ubiquitous wound sepsis can only be described as phenomenal and this applied not only to the flesh wounds but to wounds containing gas-gangrene organisms, to compound fractures, to thoracic cerebral, maxillo-facial and to a lesser extent abdominal wounds and to burns It was felt that penicillin prophylaxis was in large measure responsible for the astonishingly low mortality figure of 3 per cent over 60 000 serious cases operated upon of necessity in forward areas and for the fact that approximately 93 per cent of straightforward flesh wounds could be sutured and were healed within three weeks of being received

Other fields of prophylaxis which have been tentatively explored are those of venereal disease the post-operative complications and mouth and throat infections Little purpose can be served at present by simple flights of imagination but such lines—which are being followed up—as the inspiration of penicillin impregnated air open up fields of the most far reaching significance

B **Therapeutic.** With the proviso always that the causal organism is sensitive and that the treatment is combined with adequate surgical

measures the following list admittedly incomplete gives some of the more important pathological conditions in which penicillin therapy is beneficial Details will be found under appropriate headings —

1 *General Infections*—Septicæmia Pyæmia (Gas Gangrene Tetanus Diphtheria)
2 *Local Infections*—Soft Tissue Wounds Burns Local Abscesses Cellulitis Erysipelas Bursitis Tenosynovitis Lymph angitis Phlebitis
3 *Nervous System*—Wounds Meningitis Encephalitis Cerebral Abscess Sinus Thrombosis
4 *Respiratory System*—Chest Wounds Pneumonia Empyema Bronchiectasis Lung Abscess Pericarditis Endocarditis
5 *Alimentary System*—Mouth Infections Gingivitis Pharyngitis Tonsillitis Cholecystitis (Pancreatitis) Cholangitis (Hepatitis)
6 *Skeletal System*—Compound Fractures Osteomyelitis Arthritis.
7 *E N T*—Sinusitis Otitis Mastoiditis Tonsillitis Pharyn gitis Sinus thrombosis Laryngitis
8 *Eye*.—Wounds Blepharitis Conjunctivitis Corneal Ulcers
9 *Skin*—Boils Carbuncles Impetigo Ecthyma Sycosis (Acne Seborrhoeic Dermatitis) Lymphangitis.
10 *Gynæcology*—Salpingitis
11 *V D*—Gonorrhœa Syphilis
12 *Excretory System*—Nephritis (Cystitis) Perinephritis (Orchitis)

THE SULPHONAMIDES AND PENICILLIN

From the foregoing descriptions it will be obvious that certain fields of therapy are definitely restricted to either one of these two great therapeutic agents It is equally definite that neither is antagonistic to the other In fact, in some conditions they would almost seem to be synergistic But the decision as to which should be used or whether both should be used in infections due to organisms susceptible to both offers slightly more difficulty The great drawback to the sulphonamides is their toxicity This admittedly varies from drug to drug and from patient to patient but there is no doubt the majority of cases treated by the sulphonamide group show some symptoms varying from the subclinical to the fatal directly referable to the drug itself This effect is to all intents and purposes entirely absent with penicillin On the other hand the oral administration of the sulphonamides by tablets is a great deal simpler than the various parenteral methods required for penicillin We feel however that where a choice is possible penicillin should be selected and used alone in adequate dosage The penicillin field is much wider than that of the sulphonamides and it is without risk The very definite value of penicillin in sulphonamide resistant infections should always be borne in mind. If the choice is available of a single drug just as potent and non toxic it would seem sensible and right to use it in preference to a drug (difficult to choose in the first place from a complex and varied group) which is potentially if not actually toxic and which can give no superior results even if the latter is easier for the patient to take and the medical staff to give

THE MORE RECENT ANTIBIOTICS

Since the full fledged development of penicillin therapy research has proceeded apace and a number of other antibiotics are now in routine or experimental use Amongst these are —

1 **Streptomycin.**—*The* use of this substance (derived from the streptomyces sub-group of the actinomyces) dates from 1944-45 In pure form it is a white powder (as supplied commercially yellowish) easily soluble in water easily destroyed by strong alkalis but active in normal tissue fluids and in pus. It is not absorbed from the alimentary tract (but acts locally inside the gut) and is usually given either intramuscularly or intrathecally It can also be applied locally inhaled and injected into serous cavities

Streptomycin though lethal to many organisms has found its chief importance in the treatment of various forms of tuberculosis and in bacterial endocarditis It tends to produce resistance quicker than penicillin and is certainly a potentially more dangerous drug in its tendency to produce permanent vestibular dysfunction and deafness

Even its less toxic form (dihydrostreptomycin) can produce these results in an appreciable percentage of patients. together with skin rashes vomiting pyrexia eosinophilia and albuminuria Its application is therefore in the main limited to selected cases of tuberculosis and infections in which the organism has been proved to be penicillin resistant

2 **Chloromycetin** (Chloramphenicol) was discovered in a field in Venezuela from another streptomyces It is the first antibiotic to be commercially synthesised. It acts on many Gram negative organisms which are penicillin resistant as well as on some Gram positive organisms and spirochætes. But its chief field of application is against the rickettsial infections It is quickly absorbed from the alimentary tract but its bitter taste necessitates its administration in capsules Its toxicity is minimal although granulocytopenia has been reported Whilst still virtually in the experimental stage most encouraging results have been reported in the treatment of typhus typhoid fever brucellosis, psittacosis and virus pneumonia

CHAPTER XII

PHYSIOTHERAPY AND RADIOTHERAPY

PHYSIOTHERAPY

ITS OBJECTS

THE surgeon s art does not come to an end when the last stitch has been introduced and the dressing applied after an operation, or when the displaced ends of a fractured bone are replaced in anatomical alignment In many surgical diseases the operation —important as it may be—is but the beginning of a course of treatment which is designed to restore the function of the local operation zone and the patient s general bodily activity to normal. Many physical agencies have been brought to the surgeon's aid in his attempt to restore health after removal of diseased tissue or after the repair of damaged parts

The Prevention of Deformity will be emphasised in many chapters of this book and is an outstanding consideration in the treatment of fractures nerve injury and lesions of the central nervous system A few examples only will be given here to impress upon the reader the utmost importance of this aspect of surgical work When a peripheral motor nerve is injured the muscles supplied by it become paralysed and atrophied while the unopposed group gradually contract and pull the joints on which they act into the position of the full range of their movement unless the limb is adequately splinted to prevent this defor mity Such a condition is very difficult to correct owing to the fibrosis of the contracted muscles and to the inability of the paralysed muscles to regain their function even when the regenerated nerve has reached them yet it is so easily prevented by splinting in such a position that the paralysed muscles are relaxed and their opponents are stretched

Many injuries *e.g* fractures and dislocations and many diseases *e.g* infections of joints require immobilisation as the result of which a fear will always exist that stiffness or fixation of joints may occur Where it is possible the parts must be placed in the position in which their function is at its best in spite of the possible handicap of adhesions The *position of function* of the hand (Fig 73) is an excellent example and another is the position of election for ankylosis in a joint the exact position in each joint having been carefully worked out to ensure the maximum function of the limb

After operations *position* is often of the utmost importance After the radical removal of a carcinoma of the breast the movements of the shoulder are well-nigh perfect in spite of the mutilation of the pectoral group of muscles. If however the arm were kept close to

the body during convalescence a very limited range of movement would result, but by placing the arm on a pillow abducted to 75° from the body a full range of movement can be obtained

The prevention of deformity is nowhere better exemplified than in the treatment of burns in the region of joints Scar tissue inevitably contracts unless prevented by careful splinting and severe flexion of a joint may follow a burn. In such patients, after the initial stage has passed, treatment must include careful splinting in a position of extension until all risk of contraction has been overcome

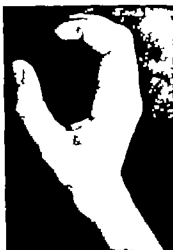


FIG 73
The position of function.

Restoration of Function.—It is a sad commentary upon our scale of values that it has required a second world war an attack upon the civilian voter to persuade the Government that it is not enough to tend the wounded but that every injured person needs to be restored—as far as possible—to full wage-earning capacity Again in the past no influence could persuade insurance companies dealing with workmen's compensation that a man after treatment needed a period of graduated work to get him back to full strength for active duty In connection with infections and injuries of the hand I have been preaching the overwhelming importance of restoration of function for many years Total war has at last convinced authority that rehabilitation is an essential part of their responsibility The following description of physical agencies at our disposal will be better appreciated if this final objective is kept in mind Further let it be understood that our task is easier in every condition if diagnosis has been promptly and correctly made and efficient treatment has been made available at the earliest possible moment

ITS METHODS

The physical agencies used in the rehabilitation of sick and injured people may be classified as follows —

A Massage

B Movements and Exercises { Active, Passive }

C Heat { Moist, Dry, Actual }

D Electrical Methods { Galvanism, Faradism, Sinusoidal Current, Diathermy }

E Light

Massage has as its objects (1) to stimulate the circulation of an injured or immobilised part by acceleration of the flow of venous blood, so increasing the supply of fresh arterial blood (2) to assist in the absorption of inflammatory exudates by again increasing the venous and lymphatic drainage (3) to maintain the tone of the muscles preventing their atrophy and keeping them in training so that they can resume work quickly when the disability has been cured (4) to prevent the formation of adhesions in and around joints and to help to remove articular effusions (5) when given to the whole body to act as one of the most powerful means of inducing sleep in patients suffering from insomnia due to nervous strain or breakdown and (6) greatly to increase the tone of the internal organs thus assisting in the cure of constipation etc.

Massage has become a complex subject and has been divided into several types *Effleurage* is a simple stroking movement with the flat of the hand which has been dusted with talcum powder The stroke from the periphery towards the heart is strong and the return is light The strokes are at first light and gentle and become increasingly strong and deep This drives blood and lymph onwards and encourages the entry of new blood which is laden with antibodies *Petrissage consists of a series of kneading movements with the* hands starting at the periphery and working upwards to the root of the limb This is designed to promote the absorption of exudates and to improve the circulation *Tapotement* denotes the rapid repetition of sharp blows with the ulnar border of the fingers and palm alternatively with each hand. These blows tend to stimulate the vessels of the area and so to increase the blood supply

Movements and Exercises.—PASSIVE MOVEMENT is carried out by the masseuse and not by the patient Joints are moved very gently and the range of movement increased as rapidly as possible It should start at the earliest moment must produce no pain and must not interfere with the healing of the diseased or injured part It is customary to carry out the movements after the muscles and joints concerned have been massaged It aims at keeping moving parts supple and free from adhesion so that when active movements are resumed everything works smoothly

ACTIVE MOVEMENTS *must replace passive as soon as* possible and this entails confidence and mental effort on the part of the patient Care must be taken to prevent weak muscles from attempting too severe a task and their work must be carefully graduated As an example an internal derangement of the knee-joint may require considerable immobilisation with the result that the quadriceps muscle is weak and wasted In treatment the limb is placed fully extended on a couch and the patient is instructed to tighten the muscles of the thigh later the muscles are able to extend the knee when the limb is supported on the side and finally sufficient strength has been regained for extension to be produced in the normal way

Such active movements are sufficient for minor maladies and trivial muscular weakness but after a serious nerve injury or following anterior poliomyelitis, the muscles demand more complicated and

co-ordinated movements than can be produced by word of command. Exercise by machines has become a recognised feature of re-education and a modern fully-equipped department will have a large number of mechanical contrivances some simple others highly complicated, but all designed to exercise a definite group of muscles and to produce a co-ordinated series of movements In these machines an adjustment of the moving parts is provided so that the effort required can be made increasingly more arduous as the muscles regain their power

Heat produces a vasodilatation of the surface vessels and this leads to an increased flow of arterial blood to which process the name active hyperæmia is given. Heat may be applied in many ways

MOIST HEAT —The hot fomentation is the best known method of applying moist heat It is prepared by cutting out four layers of lint to a size well overlapping the inflamed area These are placed in a calico wringer and immersed in boiling water for one minute The water is completely wrung out of the lint, which is applied to the skin and covered with a layer of waterproof material and wool and bandaged in position. Hot fomentations have many disadvantages First they lose their heat within a minute yet heat is their only virtue second they tend to seed out pustules on previously healthy skin third they are the worst offenders in the contamination of wounds with secondary organisms fourth their use induces a wet, sodden furrowed and white condition in the skin In fact they break every canon of modern technique concerning the treatment of wounds Let us have the courage of our convictions ar l banish hot fomentations from active surgery to a museum of surr l history Antiphlogistine is a far better vehicle of heat which ca e retained in these dressings by the application over them of an electrically heated pad.

For many purposes hot baths give better results than hot dressings and if the part can be easily immersed this method has many advantages. Special baths are made for the leg the arm and the hand, and the solutions used are iodine (one drachm of the tincture to a pint of water) normal saline eusol or hydrogen peroxide. The temperature should be about 110 F at which it should be maintained for thirty minutes, while the limb is immersed in the bath Saline baths play a prominent part in the treatment of burns.

Moist heat is used in the treatment of septic wounds and surface sepsis such as boils and carbuncles for which antiphlogistine poultices are of real value during the first forty-eight hours If the pus has been given adequate drainage and all tension has been relieved it is never necessary to continue with these dressings for longer than two days Furthermore since the advent of chemotherapy the necessity for the use of moist heat has practically disappeared Baths also have an entirely different applica ion which is outside the scope of the surgeon and will be found in textbooks of medicine as for example in the spa treatment of rheumati and arthritic disorders

DRY HEAT is immea urably superior in every case in which there is no septic wound or urface sepsis and even in those dry heat should

be substituted for moist as soon as the sepsis has subsided and the wound is cleanly granulating It may be obtained from several sources Radiant heat baths are of many types and sizes some being large enough to include the whole trunk and thighs and others designed for a small area such as the hand (see Figs 63 and 120) These baths are supplied with electric lamps coupled with a number of switches so that the temperature can be regulated Another source of heat extensively used to-day is from the infra red end of the spectrum Small portable applicators may be obtained for use in private houses and for small areas while larger installations are available for the treatment of the body as a whole

These methods of treatment produce their effects on the surface only and in deep-seated lesions it is desirable to obtain heating of the more deeply placed tissues This is possible by the use of diathermy and short-wave therapy (p 215)

Dry heat is used for many purposes in treatment One of the chief factors in the causation and maintenance of shock is the loss of body heat and radiant heat baths are the best means of counteracting surgical shock. Operating theatres are kept well heated for this reason, and the bed is warmed by radiant heat cradles for the reception of the patient after operation. Many lives were saved during the first Great War by the use of hot resuscitation chambers in the advanced and main dressing stations and casualty clearing stations resuscitation rooms were prominent features of casualty reception hospitals in bombed cities in this war Dry heat is also of great value in the treatment of septic wounds and in a great variety of inflammatory lesions such as fibrositis lumbago rheumatism rheumatoid and osteo-arthritis neuralgia and neuritis Especially important is it in assisting the recovery of movement after injury or infection as for example in the restoration of function in the fingers and hand

A specialised type of bath embodying many of the virtues of both dry and moist heat is that known as a wax bath in which melted paraffin wax in a special bath is maintained at constant temperature by thermostatic control It is a most useful method for many conditions both surgical and medical

ACTUAL HEAT by direct contact is used in surgery for many purposes and is applied by means of a cautery The *actual cautery* denotes the use of iron rods of varying shapes and sizes heated to a dull red heat It is rarely applied in this form to-day owing to the facility with which cautery points can be heated electrically As a means of producing counter irritation the actual cautery is utilised to inflict a number of parallel seared lines on the skin over a painful area *e.g* in the back especially when all other methods have failed and a strong neurasthenic element is present The *electric cautery* (Fig 74) consists of a platinum wire loop of varying shape and size mounted in an insulated handle and connected to an electric battery or to the main supply via a rheostat The platinum point can be brought to any degree of heat by regulating the current It has completely replaced the actual and Pacquelin cautery for many purposes Hæmorrhage from mucous surfaces and the depths of wounds may be arrested

by sealing the vessels with a dull red heat Hypertrophied muc membranes e.g in the nose in minor degrees of prolapse of rectum and in caruncles of the female urethra may be reduced linear cauterisation and hæmangiomata and small tumours of skin and mucous membranes such as papillomata and polypi be removed by cauterisation. The so-called diathermy caut will be described below

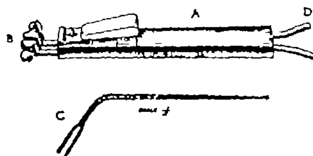


FIG. 74

An electric cautery (Allen & Hanburys.)

A, is the insulated handle with its contact key; B, the clamps to which the cautery points C are fixed; and D points for attachment t the electrical supply

ELECTRICAL METHODS

The Galvanic Current is a constant current derived from a batt It is used in conjunction with the Faradic current in testing reactions of muscles and nerves, and in treatment it has a mi beneficial action by stimulating the surface vessels It is chi used in the method of treatment known as ionisation If metal electrodes are covered in lint which is soaked in var solutions and applied to the skin the passage of a galv current will drive the positive and negative ions into the from the opposing electrodes This phenomenon is made use in the treatment of rheumatic or traumatic lesions, zinc io or salicylate ions being driven into the skin from the posi or negative electrodes.

The Faradic Current is an alternating current produced by induction coil It is used in conjunction with the galvanic in tes muscles and nerves (Chap. XLIII) In treatment it is invalu in the stimulation and re-education of wasted muscles

The Sinusoidal Current is also an alternating current patient or one of his limbs is placed in a bath of warm water and current is passed through it This is recommended for cases paralysis and chronic nerve pain

Diathermy is a term which has been rather loosely applied to co a range of electrical manifestations Essentially diathermy high frequency alternating current with a very rapid rate

sustained oscillation It is used in four separate ways medical diathermy surgical electro coagulation electro desiccation and surgical cutting

In MEDICAL DIATHERMY the two electrodes are of considerable surface area and the current passes from one to the other through the soft tissues of the patient which lie between them Heat is produced in these tissues but it has been shown that the current flows chiefly round a limb in the plane of the subcutaneous or deep fascia and little passes directly through the muscles in a direct line from one electrode to the other The heat produced therefore is largely confined to those tissues lying close to the electrodes Medical diathermy is used in the treatment of a large number of diseases *e g* gonococcal lesions in the vagina urethra cervix and tubes of women in the epididymis prostate and vesicles of men, and in rheumatic mani festations and arthritis of varying types

SURGICAL DIATHERMY covers three distinct fields of usefulness

Electro-coagulation is produced when one electrode is reduced to a very small area such as a metal button or a needle point The current is concentrated at the point so that the cells are coagulated and killed by the heat This method is used in the treatment of benign and malignant growths vascular nævi and lupus vulgaris It has also a real place in the treatment of rodent ulcer especially after other forms of therapy have failed.

Electro-desiccation is produced by a somewhat different type of high frequency current and is used for the destruction of warts true papillomata of the skin painful corns and small nævi

Acusection or surgical cutting is derived from a current of very high frequency capable of producing an arc of intense heat at the electrode A wire loop or needle is used and all soft tissues are cleanly and instantaneously cut by the moving electrode This method is used by some surgeons in extensive dissections *e.g* the radical removal of the breast Small blood vessels and lymphatics are sealed by the arc and malignant tissues can be removed by it It is this type of current which has had such brilliant results in the operation of trans urethral prostatic resection

SHORT WAVE THERAPY introduced by Professor Schliephacke is based on the action of high frequency currents with oscillations of 10 to 100 million cycles per second. Whereas medical diathermy heats the tissues nearest to the electrodes short wave therapy is said to produce heat in the depths of the tissues which are traversed directly from one electrode to another It is now being used for acute subacute and chronic inflammatory diseases such as nasal sinusitis boils and carbuncles certain eye lesions axillary and cervical adenitis certain bone and joint diseases sciatica and lumbago neuritis and neuralgia and for stimulating the more rapid healing of wounds

Ultra violet Light is produced by the passage of current through mercury vapour tubes It is used for many purposes especially in those deficiency diseases in which absence of sunlight and fresh air play a part It is also used for its general tonic action and confers

increased resistance to infectious ailments It acts by producing calciferol in the deeper layers of the skin.

CORRECTION OF DEFORMITY

Should a deformity have occurred or movements of joints be restricted complete function cannot be restored until the former has been corrected and the latter made free. A complete account of such treatment is obviously impossible here but some of the methods can be indicated

The first essential to success is that each patient must be inspired by an overmastering enthusiasm to get well as quickly as he or she can.



Fig. 75

A digitorium or dummy practice keyboard. An adjustment gives variation in the tension of the springs.



Fig 76

Home-made exercisers for fingers and thumb

The competitive spirit can be a splendid stimulus and for this reason patients with similar lesions should always be treated side by side in full view of each other Later machines are of value in amusing people as well as treating stiff joints and weak muscles Often no elaborate or expensive apparatus is required and much ingenuity can be expended in designing simple home-made gadgets many patients mechanically minded will suggest their own improvements. Pulleys weights, string, etc form the basis of such machines Figs 75 76 and 78 show various types of exercisers Figs 7 79 and 80 are examples of special splints designed to overcome stiff and deformed fingers they serve here merely to illustrate the type of splint which can be adapted to many joints These appliances are designed to produce their effects by persistent traction obtained by strong elastic bands This method has many advantages over forcible manipulation

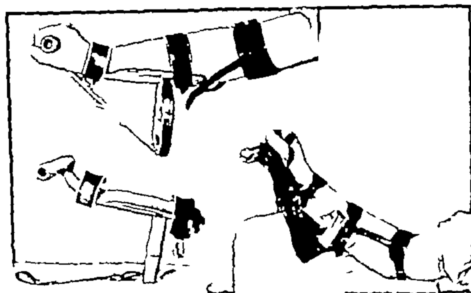


Fig. 77

A simple palmar cock up splint giving "position of function" On right it ha been adapted t pulling stiff fingers into flexion at the metacarpo-phalangeal joints. (*Kenneil.*)



Fig. 78

Miniature spring suspension pparatus for re-educating finger movements. (From Rehabilit tion and Remedial Exercises, by Guthrie-Smith. Baillière Tindall & Cox)

This apparat was made by a student of the Swedish Institut Miss Mary Troupe

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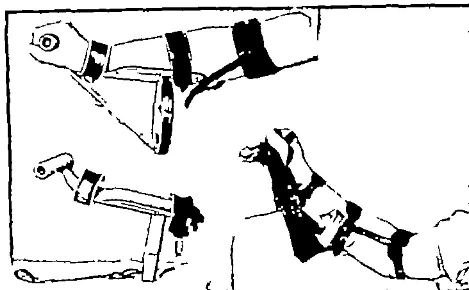


FIG. 77

A simple palmar cock-up splint giving "position of function." On right it has been adapted to pulling stiff fingers into flexion at the metacarpo-phalangeal joints. (*Kessel.*)



FIG. 78

Miniature spring suspension apparatus for re-educating finger movements.[1] (From "Rehabilitation and Remedial Exercises" by Guthrie-Smith. Baillière Tindall & Cox.)

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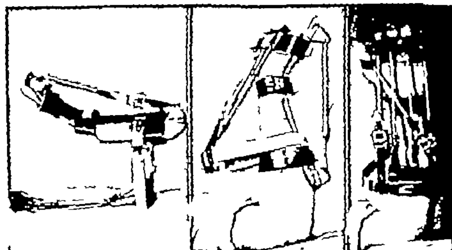


FIG. 79

A dorsal cock-up splint producing flexion of the fingers, opposition of the thumb and dorsiflexion of the wrist. (*Kanavel.*)

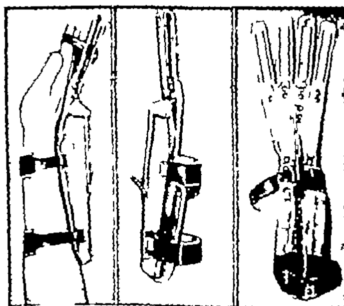


FIG. 80

Splint for obtaining full extension of the fingers and of the wrist. (*Kanavel.*)

X-RAYS

X rays are a specialised type of ether waves which have the property of penetrating many substances impenetrable to human sight The heavy metals and their salts are impervious to X rays and generally speaking the higher the atomic weight the greater the resistance to these rays It would be out of place to discuss the physics of X rays and their production, but certain details in the technique of radiography must be described.

X rays penetrate the various tissues of the human body to varying degrees The bony skeleton containing calcium salts is resistant and throws a sharp picture on a photographic film and by a specialised technique indistinct outlines of soft organs such as the kidneys can be obtained. In clinical surgery X rays are employed for two purposes viz diagnosis and treatment

X RAYS IN DIAGNOSIS

X rays are utilised in diagnosis by exposing radio-sensitive film and by the use of specially prepared screens to visualize the rays Barium platino-cyanide and calcium tungstate have the property of fluorescence when exposed to X rays and this is utilised in the manufacture of the fluorescent screen made by coating a firm piece of cardboard with one of these solutions and mounting it in a frame. Screening is an essential part in the technique of the radiography of the heart lungs and gastro-intestinal tract the localisation of foreign bodies and the reduction of fractures

X ray films are made in exactly the same way as ordinary photographic film silver salts having the same reaction to both visible light and X rays The film is enclosed in black paper which is of course penetrated by the X rays The fluorescence of calcium tungstate is used to increase the definition of the image and to decrease the time of exposure Intensifying screens are made of fine art cardboard coated with an emulsion of calcium tungstate The film which is prepared on both sides is removed from its coverings in the dark room and mounted in a special casette with an intensifying screen applied to each surface The casette when closed is light tight and its surface presented to the rays consists of a thin sheet of aluminium The time of exposure is divided by ten by this procedure and thereby instantaneous photography is possible which is of great value in taking radiograms of moving structures *e.g.* the heart

Definition of the image can be further im[illegible]roved by th[illegible] elimination of all secondary radiations, and this [illegible] ved b[illegible] use of the Potter Bucky diaphragm, [illegible] e [illegible] vide [illegible] canvas to which are applied alternating [illegible] oil [illegible] This apparatus is interposed [illegible] he [illegible] canv[illegible] strip is in slow motion

Pictures must be [illegible] pl[illegible]



Fig. 81

A lateral radiogram of a normal skull showing the pituitary fossa.



Fig. 82

An anteroposterior radiogram of normal skull showing the nasal sinuses.

to each other usually direct anteroposterior and true lateral If this should not be feasible stereoscopic films are taken Two separate exposures are made in each case the films and the patient occupy identical positions but the tube is moved 6 cm between the two exposures The films are viewed in a special apparatus which enables one picture to be seen by the right eye and the other by the left eye and the component parts of the area in the photographs stand out in their true relationship

The Skull.—In injury or disease of the vault or base (Figs 81 and 82) anteroposterior and lateral views are required and if any doubt exists a stereoscopic pair of films may help to dispel it The air sinuses require a special technique The head is hyper-extended with the film placed in front just touching the tip of the nose and the front of the chin. This will show all the sinuses except the sphenoidal. Each pair of frontal and ethmoidal sinuses and maxillary antra can be compared side by side The teeth are photographed on small films in waterproof envelopes which are placed against the buccal surface of the teeth and held in position by the patient

The Spinal Column.—The standard anteroposterior and lateral view technique is applied throughout the whole column with one or two exceptions To obtain views of the atlas and axis the patient has the mouth propped open with a dental gag and the rays pass through the mouth Lateral views of the upper six dorsal vertebræ are not very satisfactory owing to the shoulder girdles and a stereoscopic pair of films may be needed **The bones and joints of the arms and legs** provide no departure from standard technique Fractures dislocations subluxations and disease of the bone are well seen, but displacements of soft parts such as intra-articular cartilages are not shown

The Thorax is most advantageously examined by the use of the fluorescent screen and by photography The expert radiologist can obtain much information from screening the range of movement of the diaphragm on each side the nature and regularity of the heart movements the displacement of the heart from its normal position and the movement of each side of the chest can be closely studied Photographs are taken with intensifying screens and without the Potter Bucky diaphragm so that exposures of one fifth to one tenth of a second are possible The patient is examined in the erect position or seated on a chair The tomograph is referred to in Chap XXII

The level of air or fluid in the pleural cavity will be shown while evidence of tuberculous disease or neoplasm of the lungs can be identified. Further detailed examination of the lungs is obtained by the injection of lipiodol into the trachea (Fig 83) The posterior mediastinum is best seen in photographs taken in the left oblique position the size of the aortic arch and the presence of tumours or enlarged gland can be demonstrated (see illu trations in Chap XXIV)

The Gastro-intestinal Tract is not visible unless filled with an opaque solution Barium sulphate is an insoluble salt and is opaque



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to X rays It is put up in several different preparations by various firms It may be mixed with milk hot chocolate or Horlick's malted milk and made into a thick creamy consistency Screening in skilled hands gives more reliable and more extensive information than photography

The *Œsophagus* is examined while the patient is standing erect in the left oblique position, the barium meal being watched in its progress down the œsophagus (Fig 84) If any doubt exists a small piece of cotton wool is well soaked in the meal and swallowed Its progress is slower than the liquid and it can be watched more easily and will



FIG. 83

Photograph of the chest, illustrating the use of lipiodol injection into the bronchial tree to show a moderate degree of bronchiectasis



FIG. 84

A lateral view of a barium swallow held up in the œsophagus by a carcinomatous stricture.

be held up by slight strictures which would prove no obstacle to liquids Photographs are taken by the double intensifying screen technique without the diaphragm The *stomach* is examined by visual screening during its filling with the meal Peristalsis is watched and compared with normal and the general shape size and position of the organ noticed Massage with the gloved hand is then carried out to move the barium about so that the curvatures the pyloric antrum the pylorus and the first part of the duodenum can be examined Photographs will be taken at definite intervals and the time noted at which the stomach is completely free from barium which should normally occur within four hours Filling defects due to growths and craters of peptic ulcers can be visualised.

The Duodenum —The first part of the duodenum is physiologically closely allied to the stomach and can be easily demonstrated and examined by visual screening and photography The other parts of the duodenum are not easy to investigate as the meal is passed very rapidly

into the jejunum The first part is known radiologically as the Duodenal Cap being shaped somewhat like a triangular hat or ace of spades

The Small Intestine yields few results of value from barium meal examination Abnormalities of position may be seen and occasionally the appearance suggests the presence of chronic intestinal obstruction The meal should have reached the ileocæcal valve in two and a half to three hours and be entirely passed into the colon in six to eight hours.

The Appendix can be visualised in many patients but its non appearance is no evidence of disease It is examined by screening and palpation during a barium meal after the small intestine has emptied itself into the colon. It should be clearly understood that a diagnosis of chronic or subacute appendicitis is never justifiable on X ray evidence alone

The Opaque Enema is used for the investigation of the rectum and large intestine The patient is to be prepared in every respect as if he were to be operated on for rectal disease A suspension of barium sulphate in water is slowly injected by an enema syringe or merely by gravity from a douche can. The patient lies on the back with the tube below and the screen above and the passage of the enema is carefully noted Photographs are taken by the double intensifying screen technique with the Potter Bucky diaphragm and will show filling defects from growths and strictures If diverticulitis is suspected a final photograph must be taken after the opaque enema has been washed out during the following day The little pockets of barium in the diverticula will be left behind and give a typical picture (see Chap XXIX)

The Biliary Tract.—Gall-stones do not show on a direct X ray photograph except in a small proportion Recent advances in technique have made it possible to visualise the gall bladder a process known as Cholecystography It cannot be said that the method is yet perfect but it does add much to the armamentarium of the diagnostician Sodium tetra iodophenolphthalein is opaque to X rays is secreted by the liver cells and appears in the bile It may be administered by the mouth or intravenously the latter method giving definitely superior pictures but as it is accompanied by toxic symptoms in so many patients the oral route has become the routine method The patient having been carefully prepared for forty-eight hours is kept on a fat free diet during the whole of the day before examination and no food is given after a light supper at 7 P.M. with which is taken the keratin-coated capsule of the drug Twelve to fourteen hours later photographs are taken and then a fatty meal is given further photographs are taken two and four hours later The gall bladder should be seen filled and distended at the first examinations and partially contracted and filled with concentrated bile later

A normal gall bladder will show a regular pyriform shadow if the cystic duct is obstructed no shadow will appear and if the gall bladder is full of stones a curious honeycombed type of shadow may be seen (see Chap XXXIII)

It must be clearly realised that only positive findings are to be relied upon and that the absence of a shadow is not sufficient evidence of a diseased gall bladder

Hepato-splenography —The intravenous injection of thorium dioxide will demonstrate lesions of liver and spleen in cases of cirrhosis neoplasms, etc. The use of thorotrast however is not yet proved to be free of danger

The Urinary Tract.—The close anatomical relationship of the colon to the kidneys and ureters makes a careful preparation of the patient an essential preliminary to all urinary radiography for the outlines of the kidney can be completely obliterated by gas in the colon. The urinary tract i e kidneys ureters and bladder is examined by photographs the patient lying supine with the tube above and



FIG. 85

The appearances produced during an intravenous urography in a normal patient.



FIG 86

An instrumental pyelography of the right kidney in the same patient.

A study of these two photographs shows the differences in density and detail produced by the two methods

the film below During the exposure the patient is instructed to hold the breath Double intensifying screens and the Potter Bucky diaphragm are used A lateral view must also be taken so that the relationship of radio-opaque shadows to the vertebral column can be defined this being of importance in the differential diagnosis of renal and biliary calculi

Intravenous Urography permits the visualisation of both renal pelves ureters and the bladder with an opaque fluid. Twenty cubic centimetres of uroselectan B are injected into a vein in the antecubital fossa and the dye should make its appearance in the urine within 4 minutes Photographs are taken at 3 8 12 25 and 40 minutes (Fig 85)

Instrumental Pyelography is somewhat more complicated in that a cystoscope must be passed in order to introduce into the ureter a catheter through which a 20 per cent solution of sodium iodide is injected into the renal pelvis The patient must be fully conscious when the injection is made and the fluid must not be introduced at a pressure higher than 15 mm of mercury lest the kidney be damaged (Figs 86 and 8)

Intravenous urography has become the routine method as it is

so simple to perform and gives very satisfactory results The density of the shadow is not great and in stout subjects points of fine detail are not shown and the method is not suitable for any patient whose renal function is seriously impaired Instrumental pyelography results in a much denser shadow and is reserved therefore for patients in whom either the intravenous urogram has left a doubt in the minds of the surgeon and radiologist or in whom the intravenous route is contraindicated

The ureters can be visualised by intravenous and instrumental pyelography and by the passage of an opaque bougie through a



FIG 87

Another example of an ascending pyelogram showing filling defect in the centre of the pelvis due to an air bubble



FIG. 88

An anteroposterior view illustrating the arrest of lipiodol in the spinal theca by a neoplasm.

cystoscope These methods are essential in the recognition of a small shadow suspected of being a ureteric calculus

The bladder is examined by photographs which will reveal the presence of radio-opaque calculi The bladder itself may be visualised by filling it with 20 per cent sodium iodide solution and photographs should be taken in the anteroposterior lateral and right and left oblique positions A cystogram will show the presence of diverticula

The Central Nervous System.—Intracranial disease can occasionally be diagnosed by special radiographic methods Ventriculography is a method whereby a needle is introduced into one lateral ventricle cerebrospinal fluid withdrawn and replaced by sterilised air Radiograms show any deformation of the ventricular shadows The pineal gland usually contains areas of calcification and by special technique it can be shown in anteroposterior and lateral pictures Its shadow should be strictly in the middle line and its displacement may give an indication of the presence and location of a cerebral tumour

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The Central Nervous System.—Intracranial disease can occasionally be diagnosed by special radiographic methods Ventriculography is a method whereby a needle is introduced into one lateral ventricle cerebrospinal fluid withdrawn and replaced by sterilised air Radiograms show any deformation of the ventricular shadows The pineal gland usually contains areas of calcification and by special technique it can be shown in anteroposterior and lateral pictures Its shadow should be strictly in the middle line and its displacement may give an indication of the presence and location of a cerebral tumour

The Spinal Cord may be investigated and the level of tumours decided by the injection of lipiodol an oily inert substance containing iodine 1 c c of which is injected into the cisterna magna Being of a higher specific gravity than cerebrospinal fluid it sinks to the bottom of the dural space in the sacral region of normal persons whereas it will be held up if this space is narrowed or obliterated by growth or inflammation (Fig 88) If this should occur a second injection is made into the lower part of the dural canal in the region of the third lumbar vertebra and the patient tilted head downwards The resulting pictures give the level and the extent of the obstruction.

Foreign Bodies may be localised in several ways Careful screening should give an indication of their position and photographs taken in two planes exactly at right angles to each other give more certain information. Exact localisation can be done by certain complicated methods which need not be described here

Arteriography—By special technique it is possible to take photographs of the arteries of the upper and lower limbs by injecting uroselectan into the axillary and common femoral arteries The method is of some value in the assessment of the degree of arterial degeneration in certain diseases in which the circulation of the limb is poor It is also used in the localisation of brain tumours and aneurysms

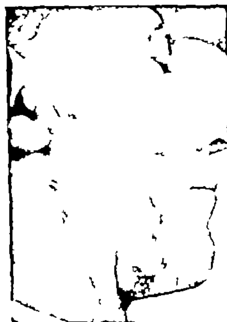


Fig 89

A photograph illustrating the cure of an extensive squamous-celled carcinoma of the cheek after radium and X ray therapy

X RAY TREATMENT

Surface Therapy—X rays are capable of producing severe burns of the skin if the dosage is excessive X ray dosage is controlled by testing the strength of the rays and by the time of exposure which will produce an erythematous blush of the skin. This is the erythema dose and it is estimated by the Sabouraud technique Small paper discs coated with barium platino-cyanide are exposed to the X rays which gradually change the green tint to a brown colour By comparison with standard tints the dosage can be correctly determined Surface lesions such as ring worm acne lupus squamous-celled carcinoma of the skin (Fig 89) rodent ulcer and secondary carcinomatous glands if close beneath the skin, react very favourably The rays are filtered by aluminium screens and full erythema doses are given

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traversing the skin that only small doses reach deep-seated tumours Deeply penetrating short wave X rays are used for deep therapy the rays being focussed in the deep-seated growth through a succession of different areas of skin known as the portals of entry One skin portal is given a full erythema dose and then on alternate days other portals are used until the full dose has reached the growth Recently a delicate dosimeter has been introduced the use of which allows an exact calculation of the dosage required All types of deep-seated growth can be attacked by this technique but in certain situations there is a real danger of damaging normal structures so seriously that deep therapy is considered unjustifiable Deep therapy is essentially an expert s work full details can be obtained only from textbooks of Radiology

RADIUM

The physics of radium activity is outside the scope of this book suffice it to say that radium salts are strongly radio-active and are almost inexhaustible since they lose their potency at the rate of $\frac{1}{2500}$th of their weight each year Radium may be administered in the form of needle or plaque containers Needles are made of platino-iridium inside which radium sulphate is carried in very small glass tubes in quantities of 0 5 1 or 2 mg The needles are inserted into the growth and have eyes which are threaded with silk or wire to permit their removal Metal plaques are but rarely used and external therapy is obtained by planting needles in a paraffin wax mould applied to the skin In the radium bomb a large quantity of radium (4 to 5 grm) is concentrated in one metal container and by special technique the bomb can be made to direct rays to deep-seated tumours in a manner somewhat comparable to a deep X ray therapy tube Fortunately the enormous expense precludes its use except in the hands of an expert

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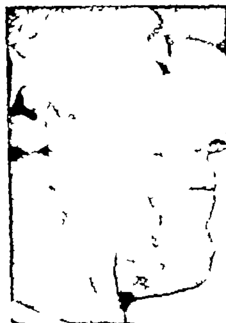


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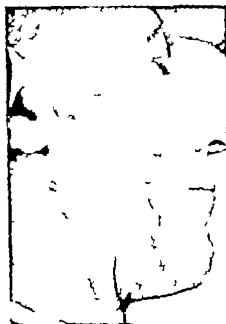


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radium and growths of the larynx and pharynx have given encouraging results from bomb therapy

Sarcoma and carcinoma show very varying degrees of response to the rays, but generally speaking the more rapidly growing and the less differentiated type of cell responds most readily

It must once again be emphasised that radium should be used only by those specially trained in its uses It is for this reason that I have deliberately refrained from enlarging this very small section

R M. HANDFIELD-JONES

CHAPTER XIII

DISEASES OF THE SKIN

INFECTIONS OF THE SKIN

INFECTIONS of the skin are of pyogenic specific or parasitic origin and may be classified as follows —

Pyogenic	*Parasitic*
Boils	Ringworm
Carbuncles.	Scabies
Cellulitis	Tinea Cruris etc etc
Erysipelas	Favus
Impetigo Contagiosa	

Specific

Tuberculous	(a) Bazin's disease (b) Ulceration (c) Lupus Vulgaris (d) Verruca Necrogenica
Syphilitic	(a) Primary (b) Secondary (c) Tertiary

Gout
Erythema Nodosum
Lupus Erythematosus
Erythema Pernio (Chilblain)
Molluscum Contagiosum
Leprosy and other tropical diseases

PYOGENIC INFECTIONS

A Boil or Furuncle is a localised infection of the skin due to staphylococcal invasion *of a hair follicle or sebaceous gland leading* to suppuration and local gangrene Occasionally the inflammation stops short of suppuration and resolution occurs the condition being then known as a blind boil A fully-developed or ripe boil consists of a central slough (the dead follicle or gland) surrounded by pus and a wall of active granulation tissue

A boil may occur in any part of the skin supplied with hairs most often in those areas subjected to rubbing or pressure *e.g* the back of the neck in men where the collar rubs the axilla and the face It begins

as a small red thickening which is tender rather than painful and from the centre of which a hair may be seen to protrude It slowly increases in size becoming conical in shape dusky red in colour painful and extremely tender At the apex of the swelling a grey white spot appears around which the skin gets thinner until it bursts and pus exudes Within three to five days the slough separates as a core which is extruded after which the swelling subsides and the cavity granulates rapidly The surrounding skin needs protection during treatment as satellite boils are likely to appear

Treatment—The blind boil should be left alone as interference may cause suppuration where none would have occurred Many boils may be aborted and others brought more rapidly to a head by the use of penicillin As soon as pus is formed a small incision is made and the area treated three times a day with Bier s suction glass. The surrounding skin is carefully cleansed swabbed with absolute alcohol painted with merthiolate and covered with a small square of gauze held in position with elastoplast to avoid the formation of satellite boils. When the slough has separated a small dry dressing will suffice The practice of applying pure carbolic acid on the pointed end of a match or probe can do nothing but increase the amount of necrosis and should never be employed and a similarly popular practice of squeezing the boil cannot be condemned too strongly as it may be the determining factor in the production of a staphylococcal septicæmia

Furunculosis or Recurrent Boils.—This is an indication of lowered resistance on the part of the patient who should be examined thoroughly to ascertain the cause Early chronic interstitial nephritis, diabetes or other serious organic disease may be present but the common predisposing factor is debility due to overwork nervous exhaustion and lack of a holiday In some patients however none of these basic conditions are present and tests of immunity resistance opsonic index etc show a high level of resistance This type of infection is by a staphylococcus of low virulence often *S albus* which is characterised by its complete inability to stimulate the body to produce a specific antibody defence The tendency to recurrence may be most persistent and treatment will often prove difficult as patients are adamant in their refusal to give up their work and go away for a real holiday The condition is deserving of more serious attention than it usually commands as such dangerous diseases as acute osteomyelitis in children and perinephric abscess and septicæmia in adults are known to have their origins in a simple boil

Treatment consists in the local attention to each boil as it occurs and general therapy to improve the patient s condition Penicillin will greatly assist the rapid subsidence of each boil but appears to have no influence in preventing recurrence The combination of sun and salt water cannot be surpassed and if possible the patient should be sent to the sea side Failing this local infra red and general ultra violet radiation should be employed

A Carbuncle starts as a staphylococcal or rarely as a streptococcal infection of a hair follicle and sebaceous gland or of a sweat gland

but whereas in a boil the process remains localised in a carbuncle it spreads more deeply When pus ruptures out of a hair follicle it enters a columna adiposa along which it follows the path of least resistance in the subcutaneous fat until it reaches the loose connective tissue meshwork beneath the skin The infection is then able to spread centrifugally and pus tracks up adjacent *columnæ adiposæ and so* reaches the surface at many points The central area becomes necrotic and pus and cellular debris ooze from it but as the opening is insufficient for free drainage the infection continues to spread at the periphery beneath the skin and an untreated example will spread over a large surface area A well-developed carbuncle shows four separate zones (Fig 90) in the centre is the necrotic area around which is a punctate zone in which beads of pus have reached the surface along the columns of fat surrounding this is a purple zone of subcutaneous pus and lastly an area of inflammatory induration Carbuncles are commonly seen on the back of the neck and are sometimes associated with diabetes and for this reason the urine must always be examined Incorrect diagnosis and imperfect treatment may lead to such an extensive spread of the infection that prolonged illness and death may follow If the pathology is understood the need for energetic treatment will be readily appreciated

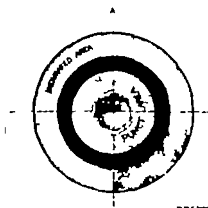


Fig 90
Drawing showing the areas of a carbuncle

Perhaps the most consistently dramatic successes of penicillin therapy are seen in the treatment of carbuncles and it is no longer necessary to discuss other methods let one example suffice An elderly man was seen whose left buttock was the seat of an immense carbuncle Within twenty four hours of parenteral penicillin his intense pain had ceased, at the end of another day the swelling was reduced to one-quarter of its original size and by the tenth day all sloughs had separated and a clean granulating surface remained. The most useful local dressing is penicillin cream and dry gauze

Should the patient be a diabetic appropriate treatment will be directed to that condition

Facial Carbuncles —The danger area of the face is bounded by a line drawn from the angle of the mouth to the external orbital process and thence upwards to the hair line Sepsis of any sort but especially carbuncles in this area is fraught with great danger owing to the possible spread of infection by the angular vein into the cavernous sinus For this reason facial carbuncles are never incised but intensive penicillin treatment is adopted Ligature of the angular vein is quite futile moreover it is entirely unnecessary

Cellulitis and erysipelas have already been described (pp 26 and 47)

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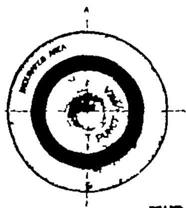


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Impetigo Contagiosa is of streptococcal origin and is most commonly seen on the face in children. The cocci gain entrance through an abrasion and form intradermic vesicles filled with a serous exudate which coagulates when the vesicles rupture a yellow crust being formed. The exudation continues at the periphery and the lesion increases in size until contiguous patches meet and coalesce. The infection tends to spread rapidly over the whole face and down on to the neck.

Treatment—The crusts must be gently removed by soaking them either in warm sweet oil hydrogen peroxide (3 volumes) or lysol (0 5 per cent.) twice daily after which the underlying lesions are covered with a mild mercury ointment *e.g* Ung Hydrarg Nit dil or Ung Hydrarg Ammon dil, or with penicillin cream. Great care must be taken to prevent the spread of the infection and in men shaving must be prohibited until the lesions are healed.

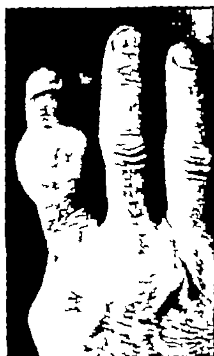


FIG. 91

A large gouty tophus of the index finger

SPECIFIC INFECTIONS

Gouty Tophi.—Deposits of sodium biurate are typical manifestations of chronic gout. They may occur in the subcutaneous tissues of the fingers and hand (Fig 91) as well as in joints bursæ and the cartilages of the ear.

Tuberculous Infections of the Skin. BAZIN'S DISEASE, or erythema induratum affects girls and young women whose circulation is poor. The characteristic nodules appear on the postero-external aspect of the legs, but are also rarely met with in the upper limb and on the face. The condition starts as a small nodule beneath the surface of the skin which gradually becomes thickened and purple in colour. The nodules are firmly fixed in the skin, have ill-defined edges but move freely over the underlying tissues. Their discoloration does not disappear on pressure. Some of the nodules break down exuding a thin serous discharge and later form typical tuberculous ulcers while others become spontaneously absorbed. The lesions are usually bilateral and are much aggravated by cold weather.

Treatment is disappointing as relapses are so frequent. Rest in bed, intravenous injections of neosalvarsan and radiotherapy all improve the local condition and curettage of ulcerated nodules will accelerate convalescence. General treatment will be directed towards the underlying tuberculosis.

TUBERCULOUS ULCERS occur as a result of (1) breaking down of a Bazin's nodule (2) extension from a tuberculous bone joint tendon sheath or bursa (3) extension from a tuberculous gland (4) spread of infection at muco-cutaneous junctions and (5) infection of a skin wound by bacilli from the surface

Treatment usually needs to be directed towards the underlying disease but wherever possible the ulcer should be excised and the wound sutured

LUPUS VULGARIS —The initial lesion is an intradermic nodule varying in size from a pin's head to a small pea It is soft semi translucent and brownish yellow in colour and on pressure with a glass slide the typical apple jelly appearance is seen A cluster of nodules coalesce to form a lupus patch which spreads by extension at the periphery by the further formation of nodules The older or central area tends to heal by scar tissue in which new lesions may occur The infection reaches the skin by lymphatic spread from adjacent mucous membranes or more rarely may be blood borne or implanted from the surface It attacks both skin and mucous membranes and is usually found on the face around the nose and mouth and on the neck, but it also occurs on the trunk and on the palm of the hand and sole of the foot It affects children and adults and is a slowly progressive chronic condition which is of little danger to life though locally destructive of tissue A squamous-celled carcinoma is apt to arise in old lupus scars

Treatment of a single patch consists in excision and suture or grafting if necessary This is rarely practicable and the best results are obtained from heliotherapy combined with local exposure to X rays the Finsen quartz lamp or concentrated ultra violet light The lesions of the mucous membranes must also be treated if a complete and lasting cure is to be achieved Patients should be kept under observation for many years even after apparent cure

VERRUCA NECROGENICA (Butcher's Wart or Anatomical Tubercle) is due to the direct implantation of tubercle bacilli into the skin and so is usually seen on the fingers hand and forearm. It begins as a papule which extends to form a warty granulating mass on an indurated base surrounded by a red or purple zone of inflammation.

Treatment is excision

Syphilitic Lesions of the skin are met with in all stages of the disease and are described in Chap X p 67

Erythema Nodosum is generally regarded as being of rheumatic origin but it seldom occurs in typical cases of that disease The lesions consist of raised indurated nodules oval in shape and of considerable size which are at first red and later purple in colour They are seen on the legs often over the subcutaneous surface of the tibia and on the extensor aspect of the feet The nodules are painful tender and hot and there may be a mild pyrexia The condition may be mistaken for a deep abscess cellulitis or even acute osteomyelitis of the tibia but the distribution and clear demarcation of the nodules and the fact that they are often multiple and bilateral should point to the correct diagnosis

Treatment consists in rest and local applications of hot dressings or evaporating lotions.

Lupus Erythematosus is characterised by oval or round patches of erythema covered by lamellated scales on the under surface of which are tiny horny plugs which project into the openings of the hair follicles The lesions tend to heal in the centre leaving a thin atrophic scar while telangiectases are seen in the active areas The scaly patches affect chiefly the malar regions of the face and the bridge of the nose producing the so-called butterfly erythema from the shape of the lesion The disease may cross the muco-cutaneous junctions of the lips and nares and attack the nasal and buccal mucous membranes It affects both sexes between the ages of twenty and fifty years is chronic and difficult to eradicate. It is believed, especially by the continental pathologists to be associated with tuberculosis but the evidence is inconclusive The patches are slightly tender and give rise to a mild burning sensation.

Treatment—No local applications seem to have any effect and radiotherapy is disappointing but of recent years excellent results are reported from the use of sanocrysin, which is given in intravenous doses of 0 1 grm weekly for twelve weeks

Erythema Pernio (chilblain) is an erythematous condition of the fingers toes hands and feet due to venous stasis occurring in young people in cold weather Chilblains appear as raised purple swellings which are tender and irritable and whose surface is often broken by rubbing They may be largely prevented by the use of thick stockings and gloves and by active exercise If there is any suspicion of a chilblain starting it may be successfully prevented by the use of this paint night and morning —

℞

Tinct iodi	ʒi
Pulv ac tannic	ʒd
Collodion flex	ad ℥i
Mft pigmentum Apply with camel's hair brush	

Calcium lactate with or without parathyroid extract is widely recommended but is most disappointing Sympathectomy has had some striking successes, but many cases relapse after the second year

Molluscum Contagiosum is a condition of unknown etiology in which multiple small rounded nodules occur in the skin. They are raised umbilicated and semitranslucent and consist of solid columns of squamous epithelium the central cells of which undergo hyaline degeneration, while others nearer the surface show an atypical keratinisation which leads to the formation of the so-called molluscum bodies The disease affects the skin of the face neck, hands and scrotum

Treatment consists in scraping or excision

Leprosy has already been described (p. 41)

Parasitic Diseases of the skin have little interest to the surgeon and they will be found described in textbooks of medicine

Indelible Pencil Lesions of the skin of the fingers are becoming more widely recognised in this country though their incidence is higher in America. A small point of pencil lead containing an aniline dye having been implanted its slow absorption leads to a chronic progressive necrotic process with either (1) a discharging sinus (2) a small profusely granulating wound or (3) a necrotic ulcer (Fig 92) Treatment consists in radical excision



FIG. 92
Indelible pencil lesion.

GROWTHS AND CYSTS OF THE SKIN

A Callosity is an area of hypertrophy of the skin with marked thickening of the horny layer due to prolonged pressure. It is commonly seen in the palms of the hands of manual workers the soles of the feet in town dwellers and on the heads shoulders and backs of certain workmen *e.g* Covent Garden Smithfield and other porters of like occupation.

A Corn differs from a callosity in having a central hard core which grows downwards causing pressure atrophy of the papillæ of the corium. In this way a conical depression is formed around which the cuticle hypertrophies and a hard avascular area projects from the surface. As a result the causative pressure is intensified and a vicious circle leads to a gradual increase in the size of the corn. They are very commonly seen on the toes where they are due to the pressure of ill fitting shoes. Two varieties are described—hard and soft corns.

THE HARD CORN is found on the outer surface of the little toe the inner surface of the big toe and over the extensor surface of the proximal interphalangeal joints of the second third and fourth toes (especially in conjunction with hammer toes). It forms a small raised conical swelling with a brown depressed centre and is exquisitely tender on pressure unless carefully tended. Infection sometimes spreads in beneath the corn and suppuration occurs with swelling and great pain. This may lead to sloughing and spontaneous cure of the corn but on the other hand the pus may track deeply and infect the subjacent bones or joints.

THE SOFT CORN occurs in the moist skin of the web between the toes where the hypertrophied epithelium becomes white and sodden.

Treatment consists in removing the source of pressure by obtaining properly fitting shoes. The corn can be kept painless by careful and regular paring away of the projecting hypertrophied skin without producing bleeding. An attempt often unsuccessful, to destroy the conical core can be made by painting the area daily with the following —

℞	Ac salicylic	gr lx
	Extr cannabis indic	gr xxv
	Collodion flex.	ad ℥i
Or ℞	Ac salicylic	gr xxv
	Ung resorcin (2 per cent.)	ad ℥i

Soft corns respond most readily to resorcin ointment (2 per cent.) It is rarely advisable to excise corns as the scar tends to become thickened and tender but intractable soft corns may be treated in this way Large hard corns on the outer side of the little toe which cannot be kept painless by paring are most suitably dealt with by amputating the little toe at the metatarso-phalangeal joint

Papillomata occur as two types—(*a*) warts and (*b*) true new growths A WART is probably never truly neoplastic but due to a virus infection One or more may occur on the fingers and hands of young people varying in size from a pin s head to an inch in diameter and having a rough surface apparently composed of three or four horny centres. Multiple warts are also seen on the penis and vulva as large soft and vascular masses in association with gonorrhoea (p 63) Many paints and pastes are advised in the treatment of warts but the simplest and most effective method of getting rid of single ones is by the use of carbon dioxide snow or diathermy multiple ones are best treated by a gauze dressing soaked in Milton lightly bandaged in position every night Fourteen to twenty applications will be required, but success is assured



FIG 93
An implantation dermoid cyst of the hand.

TRUE PAPILLOMATA are either pedunculated or sessile their surface being either smooth villous or nodular Some of them are pigmented The skin around them is normal and the lymphatic glands draining the area are not affected. These tumours may safely be left alone provided the patient consents to regular supervision but if they are subjected to pressure or friction or if they have shown recent signs of active growth they should be excised, and this especially holds true of the pigmented type Large tumours can be treated by X rays, radium or diathermy or by excision and skin grafting

Angiomata occur as capillary and cavernous hæmangiomata, and are described on p 111

Dermoid Cysts are congenital in origin and occur only in certain situations corresponding to lines of fusion of embryonic cutaneous surfaces They are seen commonly in the midline and at the outer angle of the orbits usually being clinically present at birth. They grow slowly and have a loose attachment to the surrounding structures but not to the skin itself They should be excised

AN IMPLANTATION DERMOID (Fig 93) is traumatic in origin, a small

island of squamous cells being carried into the subcutaneous tissues by some blunt instrument e.g. the blunt end of a needle (into the fingers of seamstresses). The cells continue to grow forming a cyst lined by squamous epithelium and secreting keratin. The fingers, hands and wrists are the areas usually affected. The cyst should be excised.



Fig. 94
Squamous-celled carcinoma of the hand.

Squamous-celled Carcinoma of the skin (Fig. 94) may be seen in any part of the body and is frequently associated with prolonged chronic irritation, of which the following examples may be quoted: cancer of the scrotal skin in chimney sweeps, cancers in paraffin, tar and X-ray workers and those developing in long-standing imperfectly healed scars, in lupus patches, in chronic ulcers and sinuses, and in certain syphilitic lesions such as leukoplakia. Clinically the growth may first appear as a raised indurated warty nodule which gradually spreads in the skin and into the underlying tissues (Fig. 95). Eventually the surface epithelium breaks down and a typical ulcer results, with its raised everted edges and its indurated base. In some cases the growth remains papillomatous in type with but slight surface ulceration, whilst others, e.g. on the lips, develop into a densely fibrous ulcer with little or no overgrowth. The lymph glands ultimately become involved, being hard and fixed, but there is no marked enlargement unless a heavy secondary infection is present.



Fig. 95
Squamous-celled carcinoma of the skin of the lower eyelid.

Treatment consists in excision of the growth and its lymphatic field, with appropriate plastic or grafting methods to close the wound if necessary.

Rodent Ulcer (Basal-celled Carcinoma) occurs in both sexes after the age of 40 years and the majority are seen on that part of the face above a line joining the angle of the mouth to the external auditory meatus, particularly upon the lateral surfaces of the nose near the inner canthus of the eye and on the cheek below the lower lid (Figs. 96 and 97). It is thought to arise from either the basal layers of the epidermis, the sebaceous or sweat glands or the hair follicles, and it spreads by infiltration in the skin and into the underlying tissues. It appears first as a small raised hard nodule and many weeks or months may elapse before ulceration occurs. The ulcerating rodent is apt to be mistaken for a squamous-celled carcinoma, but its edges are not so markedly everted and they are surrounded by a narrow zone of raised and thickened skin which is infiltrated but not yet ulcerated by the growth. In addition areas of attempted repair may be

seen in the centre or in the edge of the ulcerating area. The slow progress of the lesion its long history and the complete absence of



Fig 96
Rodent ulcer just beneath the inner canthus.



Fig. 97
Rodent ulcer on the malar region in front of the ear sho ing pre ulcer stage

lymph gland involvement distinguish it from the squamous-celled tumour In its later clinical course a rodent ulcer tends to fall into one of two groups the superficial and the penetrating The superficial rodent is of very slow growth spreads chiefly in the skin and subcutaneous tissues and does not infiltrate the deeper structures the penetrating type not only destroys the skin but slowly and inevitably erodes the underlying tissues including bone in such a manner that the most terrible deformities result in neglected cases before death occurs from intercurrent disease



Fig 98
Large melanoma in the middle of the back Patient alive and well, married, with t o children, t elve years after removal.

Treatment —In spite of its slow growth a rodent tumour should be removed at the earliest opportunity because eradication of the penetrating variety is difficult and if incomplete recurrence of the growth is of more rapid and virulent a type This characteristic led surgeons at the beginning of the modern surgical era to apply to rodent ulcers the label Noli me tangere The recognition of the pre-ulcerative stage is therefore of the utmost importance Removal by complete excision performed by scalpel or the high frequency cutting current is the method of choice in every operable case followed by suture or grafting Radium has had excellent results in the early superficial types. For the inoperable penetrating ulcers X rays and radium should be tried but both may result in an increase in the rate of growth of the deeper parts of the tumour Eventually nothing remains except the prevention of sepsis as far as possible

Melanoma.— A Benign Melanoma or Pigmented Mole is one of the commonest congenital abnormalities of the skin consisting of a small soft fleshy tumour which is either flat slightly raised or



Fig 99

Malignant melanoma on the side of the foot

pedunculated brown in colour and occasionally covered with hair These tumours usually continue unchanged throughout life but occasionally one may suddenly take on rapid growth and become malignant The benign melanomata need no treatment unless in an area constantly exposed to pressure or friction (*e.g* on the shoulders beneath the strap of the braces) or possibly for cosmetic reasons when they should be excised

B The Malignant Melanoma (Melanotic Sarcoma or Carcinoma) (Chap VI p 110) —These tumours may arise in the choroid coat of the eye in any part of the skin (Fig 98) and even in the mucous membranes of squamous type *e.g* the mouth The dorsum and outer side of the instep of the foot (Fig 99) and the skin around the toe-nails are the commonest situations others are the skin of the back and the nail beds of the fingers. These growths spread both by lymphatics (Fig 100) and blood stream and are characterised by widespread dissemination in the nearest lymph-gland area and throughout the visceral and skeletal systems The primary tumour may remain small yet almost every organ may be affected and in such cases the urine will contain melanin.



Fig. 100

Mass of secondary melanotic glands from the groin of the patient seen in Fig 99.

Treatment consists in local excision of the primary growth with its lymphatic field. Many cases however will be inoperable owing to blood stream metastases

THE SEBACEOUS GLANDS

Sebaceous Cysts result from blockage of the duct of a sebaceous gland by dirt or inflammation and are commonly seen (Fig 101) on the scalp face, neck back and scrotum They are frequently multiple especially on the scalp (multiple wens) and may reach a large size The cysts are attached to the skin and the orifice of the duct can usually be identified They may undergo the following complications —



Fig 101
Sebaceous cyst behind the ear

1 They may become infected in which case they form a localised encysted abscess cavity
2 Should they grow to a very large size ulceration of the skin due to pressure atrophy may follow
3 Very old long-standing cysts may even become calcified
4 They may rupture subcutaneously or externally
5 They may form a sebaceous horn from slow protusion of the contents which become inspissated and finally keratinised
6 They may become malignant being then known as Cock's Peculiar Tumour

Treatment —The cysts must be removed completely or they will recur If the orifice of the duct is included in a small elliptical incision they are easily dissected out Infected cysts should be opened and curetted with a sharp spoon and allowed to granulate from the bottom

Many so-called sebaceous cysts are not connected with sebaceous glands, but on removal will be found to contain keratin More correctly therefore such cysts should be called Epidermoids but their clinical picture and treatment are identical with those of true sebaceous cysts.

Adenomata of the Sebaceous and Sweat Glands occur in the scalp as slowly growing firm reddish tumours which may ulcerate They should be excised Another cystic adenoma rarely found in the scalp is known as the Epithelioma Adenoides Cysticum

Rhinophyma is a hypertrophic condition of the skin of the nose in elderly men due to blocking of the sebaceous ducts This is followed by a low-grade infection with fibrosis and thickening of the skin A large bulbous and pendulous mass results (Figs 102

and 103) covered by purple skin with the typical *peau d'orange* appearance

Treatment consists in carefully removing slices of the hypertrophied skin until the nose has regained its normal shape after which the raw area is rapidly covered over by newly formed epithelium from the cut ends of the ducts

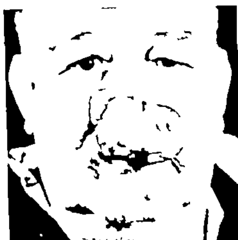


Fig. 102

Rhinophyma. A man known to many generations of students at St Mary's Hospital.



Fig. 103

The rhinophyma after removal from the patient seen in Fig. 102.

VASCULAR AND NEUROPATHIC AFFECTIONS OF THE SKIN

Erythema ab Igne is a condition of blotchy pigmentation of the skin in front of the legs due to prolonged exposure to heat and has become more common since the more general use of gas and electric fires No treatment is possible

Trophic Ulcers occur in the skin owing to malnutrition and defective sensation in lesions of the central nervous system (lower motor neurone type) *e.g* transverse myelitis tabes dorsalis syringomyelia and infantile paralysis and in injuries and diseases of the peripheral nerves They may follow slight trauma *e g* abrasions or bruises as a result of which the surface epithelium is shed and a shallow ulcer with irregular edges and anæmic sluggish granulations develops It usually proves resistant to treatment but stimulating lotions and the infra red lamp should bring about healing provided the ulcer is carefully protected. Zinc peroxide cream (40 per cent free oxygen) or penicillin cream often induces rapid healing

Perforating Ulcers are also of trophic origin, occurring most commonly in tabes dorsalis on the soles of the feet and on the borders of the great and little toes The condition usually starts with a hæmorrhagic effusion beneath a callosity under the ball of the big

16

CHAPTER XIV

INFECTIONS OF THE FINGERS AND HAND

ANATOMY.—The distal segment of a finger consists of the distal phalanx, the attachments of the flexor profundus and the extensor tendons and the fibro-fatty pulp in front of the phalanx, all of which are contained within the skin, part of this being of specialised

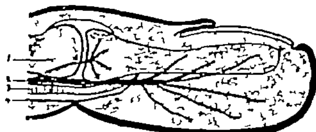


FIG 105

Longitudinal section of the distal pulp showing how the pocket is closed at its proximal end 1 head of middle phalanx; 2, digital artery—note branch to epiphysis of terminal phalanx; 3, flexor profundus tendon; 4 deep fascia.

development forming the nail and its bed. A transverse section (Fig 106) of the distal segment reveals the presence of a number of fibrous septa

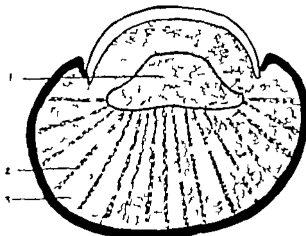


FIG 106

Transverse section through terminal phalanx showing 1 bone 2, fibrous septa; 3, fatty compartments

(usually fourteen) which pass from the periosteum to the skin and which extend the whole length of the segment The end of the

finger is thereby divided into a number of compartments which are filled with fat and in which the sweat glands lie A longitudinal section (Fig 105) shows that the fibro-fatty pulp extends to the level of the insertion of the flexor tendon and that the fibrous septa are attached to the deep fascia which covers the tendon The pulp i therefore a closed sac The branch of the digital artery which supplies the epiphyseal end of the di tal phalanx is given off *in the middle segment of the finger* and reaches the epiphysis without entering the pulp This explains the immunity of this part of the bone which i able to re-form the shaft after necrosis The dense lymphatic plexus in the pulp communicates freely with the vessel in the periosteum to which infection may be carried in the early stages of a septic finger The nail bed is a specialised derivative of the skin which forms and

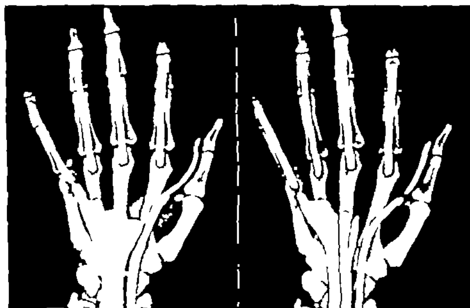


Fig 107
X ray with flexo sheaths superimposed.

Fig 108
The same showing variations.

nourishes the nail. The exposed part of the nail comprises three-quarters of its extent the remainder being concealed beneath the skin

The **tendon sheaths** of the index middle and ring fingers have *no connection with the synovial bursae* beneath the anterior annular ligament (Fig 107) They extend from the level of the distal interphalangeal joint to a point in the palm one finger s breadth proximal to the web between the fingers The deep fascia surrounds the sheaths and is attached to the sides of the phalanges in this way forming a fibro-osseous tunnel lined with synovial membrane This maintains the tendons in contact with the phalanges during movements of the fingers. The sheath of the little finger *has a similar arrangement in its digital section*, but in the palm it is continuous with the ulnar bursa which spreads laterally to form a sac reaching to the base of the middle metacarpal and extends under the annular ligament on to the anterior surface of the pronator quadratus in the forearm The tendons of the index middle and ring fingers enter this bursa just distal to the annular ligament so that the deep and superficial flexor tendons of all the fingers are contained in the ulnar bursa at the wrist The sheath of flexor longus pollicis begins at the level of the interphalangeal joint and

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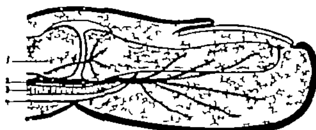


Fig. 105

Longitudinal section of the distal pulp showing how the pocket is closed at its proximal end 1, head of middle phalanx; 2, digital artery—not branch to epiphysis of terminal phalanx; 3, flexor profundus tendon; 4, deep fascia.

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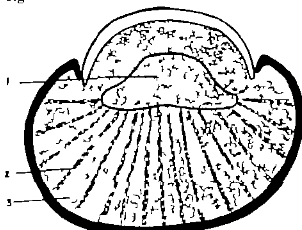


Fig 106

Transverse section through ... inal phalan ... 2, fibrous ... com

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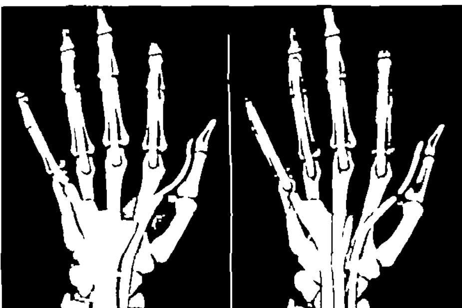


Fig. 107 — X-ray with flexor sheaths superimposed.

Fig. 108 — The same showing variations.

nourishes the nail. The exposed part of the nail comprises three-quarters of its extent, the remainder being concealed beneath the skin.

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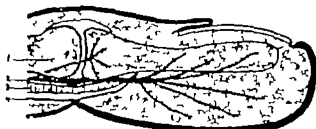


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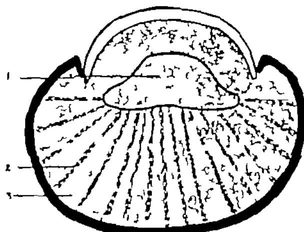


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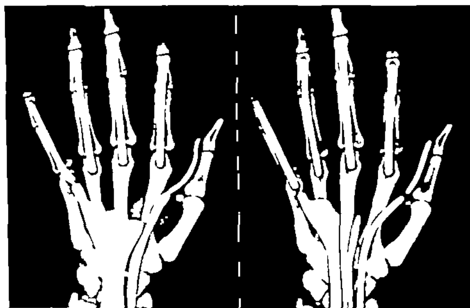


FIG 107 X-ray with flexor sheaths superimposed.

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The **tendon sheaths** of the index middle and ring fingers have no connection with the synovial bursæ beneath the anterior annular ligament (Fig 107) They extend from the level of the distal interphalangeal joint to a point in the palm one finger's breadth proximal to the web between the fingers The deep fascia surrounds the sheaths and is attached to the sides of the phalanges in this way forming a fibro-osseous tunnel lined with synovial membrane This maintains the tendons in contact with the phalanges during movements of the fingers. The sheath of the little finger has a similar arrangement in its digital section, but in the palm it is continuous with the ulnar bursa which spreads laterally to form a sac reaching to the base of the middle metacarpal and extends under the annular ligament on to the anterior surface of the pronator quadratus in the forearm The tendons of the index middle and ring fingers enter this bursa just distal to the annular ligament so that the deep and superficial flexor tendons of all the fingers are contained in the ulnar bursa at the wrist The sheath of flexor longus pollicis begins at the level of the interphalangeal joint and

extends upwards through the muscles of the thenar eminence It is continued under the annular ligament to reach the anterior surface of the pronator quadratus. At the wrist it is called the radial bursa but actually it is simply one continuous tendon sheath. There is not supposed to be any communication between the two bursæ, but it is present in so many hands that it may be considered a normal variation There is also a wide variation in the anatomy of the sheaths, e.g the ulnar and radial bursæ may have no connection with the sheaths of the little finger and thumb and the ulnar bursa may consist of two three or four separate tubes beneath the anterior annular ligament The commonly accepted arrangement is shown superimposed on an X ray photograph which illustrates their extent (Fig 108)

The **fascial spaces** of surgical importance are the Middle Palmar and the Thenar spaces Their extent and relations are as follows (Fig 109) —

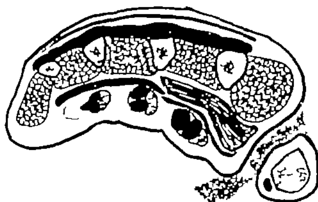


Fig 109

Transverse section f hand showing in the palm, middle palmar space in red, thenar space in blue, synovial sheaths in green on the dorsum, subaponeurotic space n red, subcutaneous space in blue

A The Middle Palmar Space.

Anteriorly it is covered by skin palmar fascia, superficial palmar arch, the flexor tendons of the little ring and middle fingers, and a fibrous sheet immediately behind the tendons

Posteriorly a fibrous sheet separates it from the deep palmar arch and the interossei muscles

Ulnar side a fibrous membrane separates it from the hypothenar muscles.

Radial side a strong fibrous septum, which is attached to the median ridge on the shaft of the middle metacarpal divides it from the thenar space

Distally it extends to the level of the distal flexion crease in the palm but sends three prolongations along the canals of the little ring and middle lumbricals.

Proximally it extends to the level of the carpo-metacarpal joints and sends a fine prolongation upwards behind the tendons to reach the pronator quadratus

B The Thenar Space

Anteriorly it is covered by skin, deep fascia superficial thenar muscles,

flexor tendons of the thumb and index finger and occasionally of the middle finger

Posteriorly the fascia covering the adductor transversus pollicis muscle

Ulnar side the fibrous septum between it and the middle palmar space

Radial side it extends to the metacarpal of the thumb

Distally it reaches the level of the radial end of the middle flexion crease with an extension along the index lumbrical canal

Proximally it reaches the level of the carpo-metacarpal joint The spaces are separated from each other by the firm septum already alluded to but at its proximal extremity this septum becomes so thin that pus can track from one space to the other although anatomically there is no communication between them. Their extent is shown in Fig 110

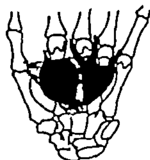


FIG. 110
Diagram showing the extent of the middle palmar and the thenar spaces. The extensions along the lumbrical canals will be noted.

The **lymphatics** of the hand are divided into a *deep* and a *superficial group* The deep group run with the veins and are of less surgical importance than the superficial. The skin and subcutaneous tissues of the palmar surface of the palm fingers and thumb are supplied with a dense network of lymphatic capillaries The dorsal aspect of the distal and middle compartments of the fingers also have this dense plexus but the dorsum of the hand and proximal segments of the fingers are less well drained At the wrist this capillary plexus is resolved into a series of lymph vessels which pass up the forearm and arm In the middle of the forearm between twenty four and thirty can be demonstrated running parallel to each other The majority pass direct to the axilla but those which drain the little and ring fingers usually enter the epitrochlear gland in front of the internal condyle of the humerus.

THE PROPHYLACTIC TREATMENT OF HAND INFECTIONS

Injuries to the fingers and hand are frequent in industrial workers but permanent disability is due to the infection which follows and not to the injury as the following figures show —

1 Seventy five per cent of disabilities following hand injuries are due to infection.
2 Seventy five per cent of severe deformities of the hand are due to infection.
3 Between 7 and 9 per cent of all cases with a total incapacity claim are due to hand infections
4 Sixty five per cent of all hand injuries which are awarded compensation are due to infection following trivial trauma

These figures prove that the importance of prophylactic treatment cannot be over-estimated for apart from permanent incapacity the number of working hours wasted by those in whom a complete cure is obtained represents a serious financial loss to both *employer* and employee The serious significance of trivial injury is emphasised by these statistics Methods of prevention therefore fall into two

groups viz the abolition as far as possible of all causes of minor injury and the prompt sterilisation of such injuries as do occur The first is the concern of the masters and men but also provides a problem for the medical worker in the field of industrial medicine The treatment of the minor scratch, cut or prick is a simple matter The facilities that are provided by industrial firms for first-aid treatment will depend on the size and efficiency of the works and these will not be fully utilised unless the men are taught to present themselves for all injuries however slight. The medical profession faces its own peculiar dangers in post-mortem rooms and operating theatres The steps to be taken in all these cases are as follows (1) Cessation of work (2) encouragement of bleeding (3) cleansing of the wound (4) sterile dressing (5) immobilisation of the arm and (6) prophylactic chemotherapy

1 **Cessation of Work** may appear unnecessary in slight injury but the loss of part of a day's work is preferable to the weeks spent in recovering from an infection of the hand.

2 **Encouragement of Bleeding**—The immediate concern of the subject of the injury and of the onlookers is to stop the bleeding This instinct must not be followed. Bleeding—especially the slow welling up from the depths of a wound—will wash out infecting organisms more adequately than anything else. If the bleeding has stopped, the wound should be encouraged to bleed by holding it under a stream of hot water or by bandaging the arm so that venous congestion is obtained, and the bleeding allowed to continue for two minutes

3 **Cleansing of the Wound.**—If the hand is clean at the time of injury it should be thoroughly washed but if it is very dirty as it must necessarily be in the case of many manual occupations more harm than good is done by washing The injured area is placed in a bath of an alcoholic tincture of iodine for five minutes the edges of the wound being separated to allow free access to iodine

4 **A Sterile Dressing** is applied, and great care is taken to ensure that the bandage is not so tight as to impede the flow of blood

5 **Immobilisation of the Arm** in a sling till bedtime and a long night's rest complete this prophylactic technique If the least swelling throbbing or pain occur at the site of injury a surgical opinion should be obtained without delay

6 **Prophylactic Chemotherapy**—The use of parenteral penicillin in the earliest stages of all hand infections has revolutionised the whole problem of the septic finger and hand.

NOMENCLATURE OF INFECTIONS IN THE HAND

The term whitlow will be entirely discarded because it has been used to cover a number of conditions of varying complexity and severity without reference to their anatomical site or pathological significance A subcuticular whitlow is merely a purulent blister on any part of the hand a subcutaneous whitlow is an infection in the subcutaneous tissues of the hand a thecal whitlow is an acute tenosynovitis and a subperiosteal whitlow is an osteomyelitis of the phalanx The

term whitlow too often conveys the impression of a trivial infection and no infection in the hand can be considered trivial leading as it may to death or a useless hand The poor standard of treatment of these infections is due to a lack of exact appreciation of their anatomy and pathology and to this the use of the term whitlow has definitely contributed

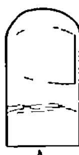
INFECTIONS OF THE DISTAL SEGMENT OF THE FINGERS

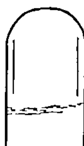
Distal Pulp Infections.—These usually follow the most trivial injuries such as pricks by a pin needle wood splinter or rose thorn or by needles or spicules of bone in surgical operations and post-mortem examinations but in a certain number of cases the infecting organisms gain entrance through the ducts of the sweat glands without injury The infection is usually staphylococcal in origin and starts in the fat of one of the compartments of the distal segment Owing to the peculiar anatomy of the closed pocket a rapid rise in tension occurs and if this is not relieved the soft tissues of the finger pulp become necrotic and the infection spreads through all the compartments and further the periosteum is involved and an osteomyelitis of the phalanx results Delayed treatment may also lead to acute tenosynovitis and fascial space abscesses in the palm. Symptoms arise within a few hours of the injury the patient becoming aware of a soreness or pricking sensation in the end of the finger This rapidly progresses to a severe throbbing pain, which prevents either sleep or rest. In the early stages the site of injury becomes swollen and tender and within twelve to twenty four hours the whole of the distal compartment is tensely swollen and very tender Later this tenseness gives place to induration and eventually an area of fluctuation appears. The middle and proximal segments and even the dorsum of the hand may become swollen, but there is no tenderness in these areas. The temperature is raised to 100 or 101 F and the patient is tired from pain and lack of sleep but there are no signs of con stitutional involvement

The only error in *diagnosis* is provided by acute lymphangitis but in this condition there is tenderness throughout the swollen area red lines of lymphangitis are seen in the forearm and there is never the same induration in the distal pulp

Treatment consists in early incision If this is withheld till fluctuation is evident the patient has been compelled to suffer needless pain and to run the risk of necrosis of the phalanx or of the more serious complications such as tenosynovitis or space abscesses in the palm. In the early stages when the swelling and tenderness are localised, an incision over the point of maximum tenderness will suffice but it is unusual for the patient to come for advice until the whole distal pulp is involved. The anatomical arrangement of the closed pocket is such that a median incision on the flexor surface can open one compartment only This leads to inadequate drainage and leaves a scar on the tactile part of the finger A lateral incision opens the pocket more satisfactorily and if one is made on each lateral surface

through-and through drainage is obtained. In advanced cases the pocket should be laid open by uniting the lateral incisions by a cut over the tip of the finger (Fig 111) or better still, by Iselin's semi horseshoe cut (Fig 112) Penicillin and sulphadiazine will hasten resolution and healing





A B

FIG. 111

Incisions for distal pulp abscess A, single lateral incision—the dotted lines mark the extent to which the fibrous septa are divided; B, two lateral incisions for more advanced cases.



FIG 112

Iselin semi-horseshoe incision.

Paronychia is a staphylococcal infection around the edge of the nail arising from an infected hangnail. At first there is a red, swollen and tender area localised to one side of the cuticle but many patients allow this to spread until there is a raised red and puffy collar around the nail. There is a general lack of appreciation of the pathology of this condition. The pus is not between the skin and the nail root but between the nail root and the nail bed If the acute stage is inadequately drained a persistently recurring chronic paronychia results

Treatment in the early stages consists in an incision in the skin at the site of the infection to expose the nail root on that side and a small segment is removed (Fig 113 A) When the infection has spread around the nail two parallel cuts are made so that a flap of skin can be dissected off the nail root (Fig 113 B) One blade of a pair of fine-pointed scissors is pushed beneath the nail, which is so divided that the nail root is lifted off its bed and removed while the exposed nail remains firmly in position on its matrix. A strip of rubber tissue is laid across the infected area and the flap replaced. The drain is removed in thirty-six hours and the incisions heal rapidly As the new nail grows a narrow slot of matrix is exposed and in this way the long and tedious convalescence after a complete nail removal is avoided





A B

FIG 113

Incisions for paronychia.

A is for early localised types, and B the more usually employed method.

ACUTE SUPPURATIVE TENOSYNOVITIS

The tendon sheaths in the fingers and hand (Figs 107 and 108) become infected in two ways They may be opened in severe crushes or lacerations and infected by direct implantation or they are secondarily involved in conditions such as distal pulp infections or acute lymphangitis in each of which the organisms are carried to the sheath by the lymphatics. The synovial membrane becomes acutely inflamed and the sheath is distended with pus If the tension is not relieved by incision the pus ruptures into the fascial spaces of the palm or into the deep planes of the forearm the synovial membrane being destroyed and the vitality of the tendon imperilled As a result the function of the hand is seriously diminished either by the loss of the tendon or by its adhesion to the sheath In many cases the infection is streptococcal in origin and during dressings of the wound it is important to avoid introducing staphylococci as well

The *symptoms* and *signs* are

1 Throbbing pain in the affected area.
2 Symmetrical enlargement of the whole finger
3 Exquisite tenderness over the course of the sheath
4 Great pain on full extension of the finger
5 Moderate flexion at all joints

The clinical picture will include the primary infection to which the tenosynovitis is secondary the onset being marked by a spread of the local signs and a marked deterioration in the general condition of the patient The swelling is not confined to the affected finger but spreads on to the dorsum of the hand and into the proximal segments of the neighbouring fingers and in neglected cases it will also affect the forearm There is some tenderness over all the swollen area, but along the course of the sheath even gentle pressure cannot be tolerated The finger at rest is held in semiflexion at all joints and if an attempt is made slowly and gently to straighten it the patient submits with some anxiety until full extension is approached and then the pain is so great that no further manipulation is permitted. This picture applies to all five digits but in the thumb and little finger the infection will probably extend into the bursae In this event the area of exquisite tenderness corresponds to the surface marking of the bursa concerned and the hand becomes greatly swollen, especially on the dorsum A raised temperature rapid pulse rate and rigors indicate the severity of the infection.

Treatment of the Index Middle and Ring Finger Sheaths—An incision is made along the lateral border of the finger—never in the middle line—opposite the middle or the proximal phalanx The choice depends on the situation of the primary lesion and the presence of secondary complications *e.g* infection in the lumbrical canals At first the sheath is opened in the chosen segment and pressure over the unexposed portions will then afford an indication of the severity of the infection Except in very early cases it will be necessary to extend the skin incision over the previously untouched proximal or middle

Symptoms and Signs.—This table shows that space abscesses are secondary to infection elsewhere in the hand and they appear as complications of the primary condition It is probable that one or more incisions have already been made and that the local and general conditions have steadily got worse The diagnosis is not easy as the whole hand is swollen more particularly on the dorsum The temperature ranges between 100 and 104 F and the patient is exhausted by pain and lack of sleep The cardinal signs are (1) The type of swelling and (2) the area of tenderness In middle palmar space

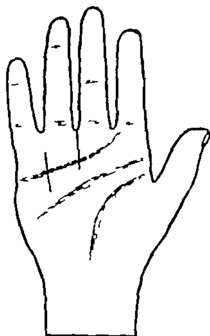


FIG 116

Incisions for middle palmar space abscess. Two vertical ones as recommended by Kanavel transverse in distal crease as advised by the author

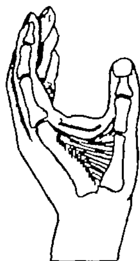


FIG 117

Incision for thenar space. It should run parallel to and immediately distal to the lower margin of the first dorsal interosseous muscle.

abscess the dense palmar fascia prevents any considerable swelling in the palm but nevertheless it is sufficient to convert the normal concavity of the palm into a slight convexity and further the swelling is extremely tense. In thenar-space abscesses the thin fascia yields readily and the ballooning of the thenar eminence is characteristic. There is tenderness over the whole hand but it is severe over the exact area of the surface marking of each space

Treatment of the Middle Palmar Space Abscess.—An incision is made in the distal palmar crease and the flexor tendons of the ring finger identified Behind these is introduced the tips of a pair of artery forceps which on being opened afford drainage to the pus A wick of rubber tissue completes the operation (Fig 116)

The *thenar space* is best approached from the dorsum The incision is shown in Fig 117 It follows the lower border of the first dorsal

interosseous muscle The lower margin of the adductor transversus pollicis is identified and a blunt pointed pair of forceps is passed around this muscle Drainage is established by a wick of rubber tissue In all these cases general penicillin therapy now forms part of the routine treatment

THE SPREAD OF INFECTION INTO THE FOREARM

The forearm becomes involved in lymphangitis and in those septic hands in which treatment has been inadequate or too long delayed

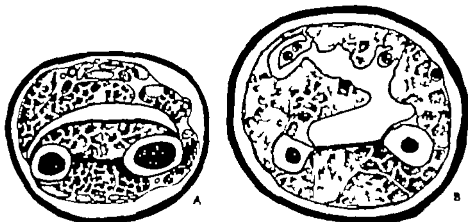


Fig 118
Cross-section of forearm showing forearm space.
A, 3 in. above wrist. B, Mid-forearm.

Pus tracks from the hand either by rupturing out of the proximal limits of the ulnar and radial bursæ above the wrist or by following the upward prolongation of the middle palmar space These routes lead to a similar space between the flexor profundus tendons and the pronator quadratus (Fig 118) The lower part of the forearm becomes

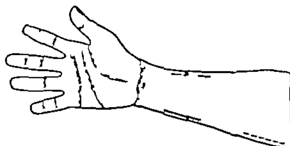


Fig 119
Incisions for deep forearm space. Continuous line shows usual one Interrupted lines those for advanced cases.

swollen tense and tender *Access to this space is obtained by* an incision along the inner surface of the forearm opposite the anterior surface of the ulna It starts 1 in proximal to the styloid process and extends for 3 in upwards (Fig 119) The attachment of the deep fascia

to the bone is incised and a finger introduced between the tendon and the pronator quadratus If necessary a similar incision on the radial aspect can be made to provide more free drainage

ACUTE LYMPHANGITIS

Acute Lymphangitis is almost invariably streptococcal in origin the organisms being introduced by a trivial prick usually in the distal segment of the finger The condition is essentially an infection of the lymphatic vessels and in the early stages no extra lymphatic inflammation occurs and no pus is formed The lymphatic plexus being infected, the process spreads rapidly through the normal lymphatic capillaries enters the lymph vessels of the forearm and finally reaches the epitrochlear and axillary glands Locally a diffuse red swelling results and within a few hours red lines can be seen running up the forearm. These are the infected lymph vessels to which the process is for a time confined. Later the infection spreads into and outside the lymphatic capillaries and the red lines become wider and finally fuse in a broad red and swollen area. Soon the whole hand is swollen, the skin is red, tense and shiny and small vesicles appear especially upon the dorsum If the condition does not resolve the brawny swelling spreads up the forearm and arm, the vesicles fuse to form large blisters the colour of the skin changes to a dark blotchy purple and abscesses begin to develop locally in various parts of the hand, or the tendon sheaths become involved. The more virulent type of lymphangitis leads to a general septicæmia and death within a few hours. Kanavel classifies this condition as follows —

1 Acute lymphangitis without local complications The swelling is localised to the finger and hand, there are the red lines in the forearm and the temperature is about 102° to 103° F The condition subsides as rapidly as it arose
2 Acute lymphangitis with local complications In this group a small abscess develops at the site of infection after the lymphangitis has subsided
3 Acute lymphangitis with septicæmia and associated with severe secondary lesions *e.g* space abscesses or tenosynovitis
4 Acute fulminating lymphangitis with a virulent septicæmia ending fatally within forty-eight to seventy two hours

The clinical picture in the first few hours is of great importance because the original site of infection is frequently the end of the finger and the condition may be mistaken for a distal pulp abscess The onset in both is similar in that a trivial prick is followed after a few hours by discomfort in the finger-end. In lymphangitis the swelling of the pulp is slight and generalised and it spreads up the finger and on to the dorsum of the hand This swelling in the distal compartment never becomes so tense as in a pulp abscess and the tenderness is far less severe but is present over all the swollen area Red lines will be seen in the forearm and the high temperature and possibly rigors suggest the presence of a lesion more serious than a distal pulp abscess

The differential diagnosis between the two conditions is of paramount importance for the pulp abscess demands early incision and drainage whereas in acute lymphangitis an incision may convert a mild case into a fatal one They are contrasted in tabular form below

DIFFERENTIAL DIAGNOSIS

—	Digital Pulp Abscess	Acute Lymphangitis in Finger-end
Cause	Slight injury—prick, etc	Slight injury—prick, etc
Earliest sign	Tense discomfort with throbbing	Discomfort; no throbbing
Swelling—		
Early	Tense—swelling moderate	Swelling slight; not tense
Late	Marked; red tense and shiny	Moderate; not tense or shiny
Spread	Up finger and on to hand.	Up finger and on to hand unexpectedly marked.
Tenderness	Over infected pulp only; marked.	Over the whole swollen area; moderate only
Red lines	Absent.	Present
Constitutional signs	Mild.	Marked.

Treatment is local and general The patient is kept in bed and a Bier's bandage is placed around the arm just below the axilla and may be safely left for six hours and re applied after one hour's interval The upper extremity from the tips of the fingers to the upper part of the arm is swathed in a linseed poultice and splinted with large quantities of wool. This is renewed every three hours It cannot be too strongly emphasised that an incision can do nothing but harm by opening up unaffected lymphatics and allowing infected lymph to enter them by which means the area of absorption is greatly increased General treatment is directed towards elimination of toxin and the reinforcement of the patient's natural defences Absolute rest and full nursing attention must be enforced and free diuresis and copious evacuations from the bowels obtained The patient's strength is maintained by highly nutritious and easily assimilable food.

The cases which progress to severe constitutional involvement become very gravely ill and some of these patients will die within forty-eight or seventy two hours without responding to anything that is done for them Others succeed eventually in overcoming the septicæmia after a long illness in which local complications in the hand and forearm arise and need surgical treatment

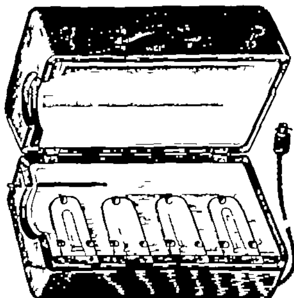
Chemotherapy has revolutionised the treatment of severe streptococcal infections of which acute lymphangitis is one of the most dangerous examples both penicillin and sulphadiazine giving dramatic improvement in most cases A blood transfusion also is of the utmost value and a suitable donor should be kept on call One of the gravest problems is the management of the restlessness and delirium which characterise septicæmia Quiet and sleep must be obtained but

morphia is dangerous in these conditions yet it may be the only dr to take effect Finally a strict watch must be kept for metastat collections of pus particularly those in the pleural cavities

GENERAL TECHNIQUE IN TREATMENT

The incisions and details of treatment have been described each section but certain general considerations are of importance

A **Anaesthetic.**—Gas and oxygen or general anaesthesia is required but in mild localised lesions nitrous oxide alone may suffice It never justifiable to use a local ethyl chloride spray



Fi 150

The author s special radiant-heat bo for the treatment of infected fingers. (Wa.)

B **A Tourniquet** should always be used, preferably the arm compressor of a sphygmomanometer

C **Incisions** are made to relieve tension and afford drainage No incision must be made until the operator has decided exactly where the pus is situated No incision should ever be made on the dorsum of the hand until every other possible been eliminated

D **Drainage Tubes** should be avc ubber tissue used

E **Fomentations** are edec nty two hou gauze soaked in para laid light wound

F **Baths of Iodine** pt of 110 F are useful in cl fec are even nd a hand found of e (F ays dry d b this dry h l p

wound has begun to heal infra red treatment should replace the radiant heat

G **Active Movements** *should* be begun at once and for this reason dressings should be reduced to a minimum and no tight bandaging allowed. Patients will find that these movements are easier and less painful if performed while the hand is in the wet or dry bath If such movements are constantly practised no stiffness in the joints will remain

H **Elevation** of the limb is of the greatest importance to encourage the flow of lymph towards the axilla

AMPUTATIONS IN THE HAND

An injured person who has suffered the loss of part of the finger or hand, has every right to expect a comfortable and painless result yet records of insurance companies contain far too many examples of painful amputation stumps as well as of crippled useless fingers which would have been better amputated many months previously For these unhappy results our profession must bear a heavy responsibility Before considering different amputation at varying levels in each finger it will be useful to study certain general principles which must be followed if good results are to be obtained

1 Let every decision be governed by the thought of ultimate function not by appearance or a slavish adherence to the old doctrine of "save all you can."

2. The bone end must be covered with good skin without tension Good skin is defined as being as thick as possible with a lining of subcutaneous fat and having a perfect blood supply

3 The scar should never be terminal

4 It should never be on the palmar surface unless absolutely unavoidable



FIG 121

Sites of election for bone section in amputations. Saw cuts through white areas leave unsatisfactory stumps. The ring finger corresponds t the middle and the little to the index finger As much of the thumb as possible is to be saved.

5 It must always be so placed as to avoid pressure points.

6 Bone section gives better results than disarticulation through interphalangeal joints If the head of either middle or proximal phalanx be conserved a bulbous stump is left and this is never really comfortable This does not always apply to the metacarpo-phalangeal joints in which the metacarpal head is of use in the hands of heavy manual workers

7 Theoretically bone section should not be performed in the presence of sepsis The use of sulphathiazole—both locally and orally—and of penicillin has largely abolished the risks and complications so that to-day this objection is no longer valid.

8 End bulb neuromata are less frequent than is commonly supposed They are nevertheless responsible for a considerable amount of disability They can be prevented by a careful identification of each nerve which is ligated high up and then injected with 5 minims of absolute alcohol above the ligature

9 While it is desirable to preserve as much as possible and to refrain

from amputating without sufficient cause it is better to amputate a finger than to retain a source of pain and an impediment to useful function. If a decision to amputate be taken, enough bone must be sacrificed to ensure a good covering Amputations involving the hand itself require much more careful consideration, while the thumb must be preserved Fig 121 shows the relative importance of bones in this connection.

AMPUTATIONS OF THE THUMB

Although the old doctrine of "save as much as possible" has been abandoned as a general principle in favour of amputating with a view to achieving the best possible functional result, in the thumb it remains of paramount importance. The thumb is practically equal in use and power to the other four fingers taken together and even very short stumps are of great value provided there is any hand left with which the thumb can act in opposition so that provided the general principles enumerated above are fulfilled, we must save as much of the thumb as possible

So true is this that, in planning an amputation of the thumb we may decide to remove less tissue than appears absolutely necessary with a view to making the stump as nearly as possible perfect by immediate or delayed skin grafting

No routine formal flap incisions can be described if the principle of saving as much healthy tissue as possible is followed. Such flaps will be made as there is skin available to cover the bone stump without tension If the subcutaneous tissues are damaged to a greater extent than tendons and bone every effort should be made to protect these living structures by an immediate skin graft When the level of bone section passes through either phalanx the flexor and extensor tendons must be sutured together over the bare bone surface

The position of the thumb after amputation is of great importance for should it be allowed to lie alongside the radial border of the index finger and to become stiff in that position, the functional result is deplorable similarly should it become stiff in abduction in the plane of the hand without any degree of opposition the function is equally bad During the first four days after amputation the thumb must be maintained in the "position of function," *i.e.* in part abduction and part opposition well forward in front of the palm Thereafter active exercises must be carried out to keep the stump freely movable

DISTAL PHALANGES OF ALL FOUR FINGERS

A formal amputation through the distal phalanx divides the bone just distal to the insertion of flexor and extensor tendons A horse-shoe incision starts and finishes at the level of the base of the phalanx and is placed far back towards the dorsum behind the line of the digital artery passing over the finger tip ¼ in. in front of the margin of the nail bed (Fig 122) It is carried to the bone in its whole extent and a palmar flap consisting of the fatty pulp is raised from the anterior periosteum of the phalanx A cut across the dorsum then unites the ends of the first incision In placing this great care must be taken to ensure that the whole of the nail bed and root is removed. Unless this is done a fragment of actively growing nail will become a serious inconvenience The bone is divided and the flap is turned over and sutured in position.

The distal phalanx should not be disarticulated at the distal interphalangeal joint as this leaves a bulbous stump Apart from this the loss of the distal phalanx cannot be regarded as leaving any residual disability

Traumatic amputations in this region are referred to on p 1207

MIDDLE PHALANGES OF ALL FOUR FINGERS

Retention of part of the middle phalanx in all four fingers leaves a useful stump. I am unable to agree with Couch's doctrine that "if injury to the index finger forces amputation at a higher level than the distal joint we should immediately sacrifice the whole finger"; should that be true of Canadian labour it is certainly not so in this country.

Whenever possible a long palmar flap is taken by two lateral incisions placed far back towards the dorsum to avoid the digital vessels and joined

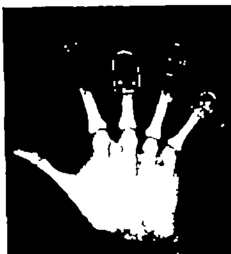


FIG. 122

Palmar aspect of left hand. Amputations at different levels. Dotted lines are incisions across the dorsum, arrows point to level of bone section.

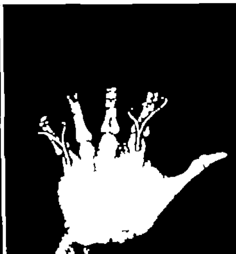


FIG. 123

Dorsal aspect of left hand. Asymmetrical racquet incision for disarticulation through metacarpo-phalangeal joints of index and little finger.

by a curved cut over the palmar surface (Fig. 122). The proximal ends of this incision are united by a cut across the dorsal aspect. The flexor and extensor tendons must be divided distal to the level of bone section and carefully sutured together over the bare bone end. The palmar flap is then turned over and stitched in position.

Again disarticulation through the proximal interphalangeal joint is not advisable.

PROXIMAL PHALANGES

INDEX FINGER.—Section of the proximal phalanx leaves so short a stump that it is of little use. The man learns to do without his index but forgets the stump is still there. It is constantly stubbing things and becomes a nuisance. Further on the right hand it is a source of embarrassment in shaking hands. For these reasons the finger should be completely removed (see below).

MIDDLE AND RING FINGERS.—Every effort should be made to save even a short stump of these two fingers. This is especially important because total removal of either allows the adjacent fingers to swing inwards towards the gap, this being particularly true of the index. It is not always recognised that flexion tends to pull the index, ring and little fingers towards the midline of the palm. When a finger is removed at the metacarpo-phalangeal

CHAPTER XV

THE SURGERY OF THE BLOOD VESSELS

ANATOMY.—An artery has three coats. The internal coat or tunica intima consists of a single layer of endothelial cells supported by fine fibrous tissue and a layer of longitudinal elastic fibres. The middle coat or tunica media is a thick layer of unstriped muscle arranged circularly and reinforced by elastic tissue and some longitudinal muscle fibres. The external coat or tunica externa is a mixture of fibrous and elastic tissue. The vessel walls have their own blood supply—the vasa vasorum—their own lymphatic drainage and are richly supplied with sympathetic nerve fibres.

A capillary has no muscle or elastic fibres, and is composed of an endothelial lining inside a fine fibrous sheath.

A vein is thinner walled than an artery, having only two coats, the inner composed of endothelium standing on a firm fibro-elastic layer and the outer consisting of fibrous tissue with a small amount of elastic fibre. Most veins have valves at intervals in their course to prevent back flow, but certain important ones are valveless, e.g. the portal system, the superior and inferior cavæ, the common femoral, internal jugular, renal and spermatic veins. In the skull certain special venous channels lie within the reflections of attachment of the dura mater and are known as venous sinuses.

Collateral Circulation.—When a large vessel is injured or obstructed, the vitality of the part supplied by it depends upon the anastomosis between the branches arising above and below the obstruction. By active vasodilatation and by a rise in blood pressure the anastomotic channels are opened up and eventually enlarged by hypertrophy, thus allowing blood to be carried to the main vessel below the lesion, and the supply to the distal parts to be restored. This process is known as the establishment of collateral circulation; several days are required for its completion, which may be delayed or prevented by disease of, or pressure on, the vessel walls. It is likely to be established more efficiently if the arterial obstruction has not been of sudden onset, and gangrene is less likely to occur under these conditions than in cases of sudden complete rupture or occlusion.

INJURIES TO ARTERIES

Contusions.—An artery is bruised by a crushing force directly applied to it, but such a contusion is unlikely to occur unless the vessel is running near a bone. A normal vessel suffers little owing to its natural elasticity and lateral mobility, and the bruise speedily heals. If, however, the artery is atheromatous or otherwise diseased, thrombosis usually occurs and dry gangrene may develop in the parts beyond, or the wall may be so weakened that it will yield slowly and give rise to a traumatic aneurysm.

Rupture without external wound may follow blows or crushes or the vessel may be injured in fractures and dislocations by the displaced bone or during attempts to reduce long-standing dislocations particularly of the shoulder Such injuries do not occur unless the artery i diseased

PARTIAL RUPTURE consists in a tear of the intima and media the external coat remaining intact When the whole circumference of the vessel is affected the elastic fibres of the intima cause it to curl up inside the lumen and thrombosis ensues the vessel becoming occluded If the tear is limited to one side only a localised thrombus forms and a weak spot may result which leads to the formation of a traumatic aneurysm In certain instances a di secting aneurysm may follow this type of injury

Symptoms consist in local tenderness and slight swelling absence or weakening of pulsation in the artery distal to the injury and coldness and loss of power in the limb Gangrene is unlikely to follow and in a few weeks the limb returns to normal unless the vessels are seriously diseased.

COMPLETE RUPTURE affects all three coats and leads to an extensive extravasation of blood This bleeding may be neither so free nor so immediate as might be expected, owing to the obstruction of the lumen of the artery by the coiling up of the intima and to a fall of blood pressure due to shock The surrounding tissues are forced apart by the escaping blood and a large cavity is formed filled with clot and liquid blood Fibrin forms at the periphery and later fibrosis leads to the formation of a definite capsule to the swelling The size and shape of this swelling are decided by the anatomical arrangement of the parts concerned and by their resistance The best examples of this type of injury are rupture of the popliteal artery due to fracture of the lower end of the femur of the axillary artery in dislocations of the shoulder and of the middle meningeal artery in cranial injuries

Symptoms are general, local and distal. At the time of injury the patient may experience a feeling as if something had snapped in the limb

(*a*) General symptoms are those of internal hæmorrhage with shock, due partly to the severity of the accompanying injuries and partly to the loss of blood

(*b*) Locally a swelling appears either immediately or after a few hours and steadily increases in size It is firm tense and tender and exhibits an expansile pulsation a thrill and a systolic bruit all of which disappear later as the layer of fibrin slowly increases in depth The skin is distended and may be very tightly stretched, and extensive bruising appears after a few days The swelling cannot be reduced by pressure and no such attempt should be made for fear of displacing the clot and precipitating a fresh hæmorrhage The local condition is described as a " pulsating hæmatoma " (Fig 120)

(*c*) The distal symptoms are produced by vascular disturbance and by pressure on surrounding structures Vascular interference includes cutting off of the arterial supply and pressure of the extravasated blood on the veins The limb becomes cold cyanosed

and swollen, and no distal pulse can be felt Pressure on the nerves produces pain tingling and numbness and later there is some loss of power and sensation, but these symptoms may be due to actual nerve injury at the time of accident

Complications—(1) Gangrene of the moist type is likely to occur as the pressure of the clot on surrounding tissues makes the opening up of the collateral circulation a difficult matter (2) Rupture or sloughing of the skin may follow if the distension is very great and the patient will die of hæmorrhage unless help is at hand (3) The injury may include rupture of the serous lining to a cavity such as the pleura or peritoneum and the patient may bleed to death internally (4) Suppuration of the hæmatoma will require urgent surgical treatment lest the skin give way and a secondary hæmorrhage result (5) A true traumatic aneurysm will be formed in some cases in which the vitality of the limb has been maintained. The cavity slowly shrinks by fibrosis of its fibrinous wall and eventually endothelium grows in and lines the sac



Fig 126

Pulsating hæmatoma due t diffusion of a popliteal aneurysm. The whole region rose and fell with ea h pulse beat.

Treatment consists in operation as soon as possible The main vessel is controlled by tourniquet digital compression or Crile s clamp and the clot is exposed and shelled out The damaged artery is identified and the extent of the injury determined If the tear does not involve the whole circumference if it is complete but clean cut and without loss of tissue, if the walls are healthy and if there is no possibility of sepsis then an arterial suture may be attempted by expert hands In all other cases ligature of each end of the torn vessel is the correct procedure proximal ligature of the main trunk must never be practised as it predisposes to gangrene and secondary hæmorrhage If gangrene or a severe secondary hæmorrhage occurs amputation is urgently called for

Injuries to arteries in the buttocks provide the exception to all these routine procedures The bleeding cannot here be controlled by pressure so that an incision must rapidly be made into the clotted area, two fingers thrust down into the depths of the wound and the actual bleeding points thus compressed The clot is removed and the parts widely exposed It may be impossible to ligate the proximal end as the artery may have retracted within the pelvis and if packing fails to arrest the bleeding the internal iliac artery must be tied through an anterior incision

Penetrating Wounds produce conditions similar to those of subcutaneous rupture except that the external wound is likely to permit unrestrained visible bleeding and to introduce sepsis The

amount of hæmorrhage depends on the nature of the wound and the size of the vessel. If the skin lesion is small and valvular in type little external bleeding will occur. Complete division of an artery allows retraction and curling up of the intima and the bleeding may cease spontaneously. Clean longitudinal cuts bleed but little as the elastic and muscular fibres tend to close the gap but incomplete wounds, especially if ragged and lacerated, cause profuse and prolonged bleeding because the opening is enlarged by the retraction of the coats. Clean punctures with a needle close immediately and the modern small high-velocity conical bullet has caused through-and-through wounds with little bleeding. Partial injuries produce similar results to the non-penetrating type, traumatic aneurysms following either from fibrosis of the clot and endothelialisation of the cavity or from the slow yielding of an intact intima through the divided middle and outer coats.

Injuries to arteries play an important part in the surgery of gunshot wounds, shell fragments causing septic and widely lacerated wounds, whereas bullet wounds may be mere aseptic punctures.



FIG. 127
Wounds in the front of the thigh from Bren gun bullets. An arteriovenous aneurysm resulted.

The local symptoms are those of the wound and of external bleeding. Distally the appearance of gangrene depends on the particular artery injured, the extent of damage to surrounding structures (particularly the accompanying vein), the state of the arteries, the general condition of the patient and the degree of sepsis present. Interesting results were obtained in casualties towards the end of the last war by immediate intubation of the damaged artery to restore continuity with narrow glass or plastic cannulæ. This was an emergency measure designed to give sufficient time for the collateral circulation to become established. After a few days the tube was removed and the artery ligated, sutured or grafted as local conditions indicated. If gangrene is avoided recovery is usually complete although in a few instances a permanent ischæmia results with coldness, weakness and anæsthesia of the limb, comparable to Volkmann's ischæmic paralysis of the forearm (Chap. L). Such temporarily devascularised limbs should be nursed exposed and slightly dependent. Heat applied to the other leg may assist development of the collateral circulation. If anoxæmia is accompanied by great swelling (e.g. crush syndrome) splitting of the fascia may also assist recovery in certain cases.

Arteriovenous Wounds.—The simultaneous wounding of an artery and vein lying in close contact results from penetrating wounds in which the contiguous surfaces of the two vessels are punctured or bruised without much disturbance of the surrounding structures, with the result that a communication is established between the two vessels. The majority follow war wounds, though some are met with in

civilian practice especially from wounds with sharp fragments of glass. The vessels most commonly affected are the popliteal artery and vein femoral artery and vein (Fig 127) internal carotid artery and internal jugular vein whilst others provide occasional examples, e.g brachial artery and median basilic vein, internal carotid artery and cavernous sinus facial artery and vein, the posterior tibial vessels and those in the orbit The communication may occur at the time of injury and little extravasation takes place No swelling and appears & the vascular injury remains unsuspected until the establishment of arteriovenous aneurysm produces its symptoms of vascular derangement in the parts concerned. These are discussed on p 277 In other patients the vessel walls are merely contused and no leakage occurs. But the damaged walls of the contiguous vessels slowly begin to soften then become adherent and finally break down at any time during the first fourteen days after injury R M Vick tells the story of such a military casualty in hospital in Salonica in the First World War The establishment of a fistulous communication was expected and carefully watched for At the moment of its occurrence the patient complained of a sudden sharp pain in the thigh and rapidly collapsed presenting a clinical picture indistinguishable from severe internal hæmorrhage

DISEASES OF ARTERIES

Acute Arteritis

This is of three types traumatic infective and embolic

Traumatic Arteritis is a process of plastic repair whereby a contusion or wound of an artery is healed

Infective Arteritis results from involvement of the arterial wall in a septic process surrounding it as in an abscess cavity the floor or wall of a spreading ulcer (e.g peptic) or a tuberculous cavity in the lung The use of an infected ligature in tying a vessel in continuity may also produce the condition The coats become hyperæmic œdematous and softened and these changes in the smaller vessels lead to sealing of the lumen by thrombosis formation while in the larger arteries the wall is likely to stretch and then give way a secondary hæmorrhage being the result

Embolic Arteritis occurs from the lodgment of a septic embolus in a small artery If the clot is virulently infected suppuration occurs and a pyæmic abscess is formed but if the infection is mild a softening of the arterial tunics leads to a gradual aneurysmal dilatation. This is the commonest cause of a spontaneous aneurysm in young people

Chronic Arteritis

Atheroma (localised or nodular arteriosclerosis) is seen in the arch of the aorta in the thoracic and abdominal aorta around the orifices of the aortic branches and in the larger arteries particularly in those areas where these pass over bony prominences Greyish white raised patches appear and slowly increase in size They are due to a thickening of the intima from an inflammatory lymphocytic infiltration, accom

panied by a deposit in the space between intima and media of necrotic cells undergoing lipoid degeneration Calcareous plaques are formed by calcification of the patches and atheromatous ulcers follow The condition has little surgical interest except as a cause of aneurysm thrombosis and embolism (Fig 128)

Diffuse Arteriosclerosis occurs in the smaller arteries and in the main vessels to the limbs It may be associated with atheroma of



Fig 128
Atheroma of the aorta.

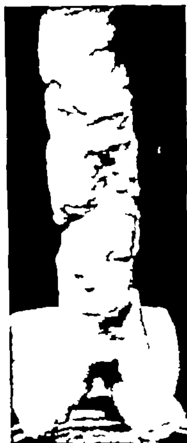


Fig 129
Mönckeberg's disease

the aorta The changes in the intima are of secondary importance the middle and outer tunics being affected by extensive fibrosis which leads to loss of elasticity and narrowing of the lumen The vessels are thickened cord like and tortuous In certain instances the degenerated areas become calcified and the arteries so hard and rigid (the pipestem artery) that when visible they may be seen to move backwards and forwards with each pulsation A primary calcareous degeneration, known as Mönckeberg's disease (Fig 129) is a particular variety of arteriosclerosis which affects the media only leading to extensive calcification. X rays will demonstrate the extent and distribution of these changes

The causation of these arterial degenerations is not clearly understood. In a mild form they are probably an expression of the reaction to fair wear and tear and are therefore to be expected in elderly people Heredity undoubtedly plays a part in those cases which are met with in young subjects Chronic alcoholism gout lead poisoning chronic nephritis physical and mental overwork prolonged anxiety and certain toxic states are all said to be contributory factors Syphilis may be the cause in some but is certainly absent in many patients.



Fig. 130

Gangrene of the hand resulting from angiitis obliterans in patient who had previously had both legs amputated for the same condition.

Arteriosclerosis concerns the surgeon because of its possible association with gangrene and of the influence it may exert upon the suitability of patients to withstand operations In the pregangrenous stage there are coldness numbness, tinglings and prickings in the extremities, while walking produces cramp-like pain in the calves which passes off after a rest This intermittent claudication may be the first complaint Gangrene usually starts in the big toe and is of the dry and senile type The treatment of arteriosclerosis comes within the province of the physician but that of gangrene is essentially surgical and has been described in Chap. IX

Chronic Syphilitic Arteritis takes the form of an endarteritis obliterans leading to complete occlusion of the lumen of small arteries and arterioles by thickening of the intima and externa. It is the dominant change in many of the tertiary lesions affecting especially the vessels of the brain and kidneys and is the determining factor in the formation of a gumma.

Chronic Tuberculous Arteritis is a similar pathological condition and accounts for caseation in tuberculous foci

Toxic Arteritis

This is exemplified by diabetes which affects the anterior and posterior tibial arteries and may lead to gangrene Amyloid disease is a toxic degeneration of the middle tunic of the smaller arteries seen in cases of long-standing mixed infection especially those which

have sinuses discharging on the skin surface It is particularly well seen in the vessels of the kidney liver spleen and small intestine

Thrombo angiitis Obliterans

Buerger's Disease is an inflammatory or toxic degeneration which attacks both the arteries and veins of a limb combined with intermittent spasmodic contraction of their walls The vessels may ultimately become occluded by a clot which in time may be canalised It is by no means confined to the Jewish race or to the male sex as is so frequently stated Little is known of its etiology although excessive smoking has been proved to be a factor As a rule it affects one leg first then the other leg and later also the arms (Fig 130) It may last for years before the onset of gangrene with attacks of numbness and claudication The treatment is most unsatisfactory as the disease is steadily progressive One case of the author's illustrates the difficulties the disease first appearing as an acute abdominal emergency from thrombosis of the ileocolic vessels which necessitated an intestinal resection for gangrene of the ileocæcal region Some years later first one leg and then the other participated in the disease an amputation being performed on one side Fortunately it is a comparatively rare condition In the early stages the object is to prevent the occurrence of gangrene Sympathectomy (*i.e.*, either lumbar or cervical ganglionectomy) holds out some hope of arresting the progress of the disease

ANEURYSM

An aneurysm is a sac containing either fluid or clotted blood which communicates with the lumen of an artery They are termed *true* aneurysms if the wall is composed of one or more of the arterial tunics and false if they are formed by condensation and fibrosis of the surrounding structures They are further differentiated into two groups internal when in the thorax or abdomen, and external if in the neck or limbs Three varieties of aneurysm are described viz spontaneous (or pathological) traumatic and arteriovenous

Spontaneous or Pathological Aneurysm

The two chief causes are disease of the arterial wall and rise of blood pressure these usually being present together Syphilitic aortitis atheroma and arteriosclerosis bring about that fibrosis and loss of elasticity which leads to yielding of the arterial wall, while other causes of localised weakness are pyæmic bacterial or mycotic emboli The rise of blood pressure which predisposes to aneurysmal dilatation is not the constant type seen in the elderly but the intermittent variety which accompanies sudden bursts of heavy work or violent exertion, especially in those who usually lead sedentary lives Men are more commonly affected than women in the ratio of 8 1 and the people of the northern and colder parts of the world provide the majority of the

other pulsating swellings One of the things the student finds misleading is the transmitted pulsation of a normal artery to the examining hand by an intervening structure *e.g* an abscess a cyst a solid tumour or even a normal organ. A similar difficulty arises when a normal artery is pushed forward by a pathological swelling behind it The abdominal aorta in thin nervous women is frequently regarded by the inexperienced as an aneurysm but in each instance the pulsation is not expansile and none of the classical signs of aneurysm are present. True expansile pulsation is seen in some bone sarcomata, nævi and goitres but these swellings do not lie in the line of an artery or diminish in size when the artery is compressed and other methods of examination will eliminate an aneurysm Finally peripheral pain, such as sciatica may be due to an aneurysm at a distance and such

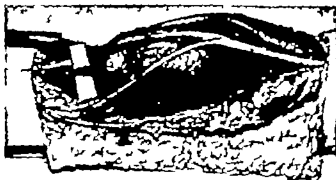


Fig 13[illegible]

Dissection of popliteal aneurysm shown in Fig. 12[illegible]. White guide is anterior to artery; immediately above is the aneurysmal sac which has leaked.

pain must never be attributed to trivial causes until the patient has been thoroughly examined for evidence of serious trouble

End Results and Complications — 1 A saccular aneurysm may undergo spontaneous cure by the clotting of its contents and fibrosis of the sac being then known as a consolidated aneurysm This happy result is accelerated by the blocking of the opening with a clot or by the sac itself pressing upon the proximal artery and so reducing the flow of blood It can never occur in the fusiform variety

2 **Diffusion and Rupture.**—Diffusion means that the escaped blood *has no access to the surface and so extravasates into the cellular tissues* (Fig 132) Rupture implies that the blood flows externally or into a mucous tube or serous cavity When an internal aneurysm gives way blood enters the pericardium pleura, mediastinum peritoneum œsophagus or trachea The signs and symptoms are pain in the heart and collapse death resulting usually within a few minutes or at most a few hours If the trachea or œsophagus have been eroded there will be profuse bleeding from the mouth

Rupture may be slow or sudden When a slow leakage occurs the swelling gradually increases in size and is no longer clearly defined pulsation diminishes in force the signs of circulatory disturbance in

the distal part of the limb become more advanced and gangrene may set in Sudden rupture is accompanied by acute pain in the region of the aneurysm and the whole area becomes greatly swollen and tense and gangrene rapidly supervenes

3 **Suppuration** may follow ligature of the artery leakage rupture of the aneurysm or a septic embolus The tumour shows all the signs of local inflammation and if no treatment is given the skin breaks down and pus blood clot and fresh arterial blood are ejected The patient dies either immediately or after a short interval unless treatment is speedily undertaken

4 **The Heart** is dilated and hypertrophied in all cases and a hæmic bruit—systolic in time—is audible at the apex

5 **Gangrene** may be due to (*a*) pressure on the main venous trunks and is then moist in type or on the arteries of the collateral circulation when it is of the dry variety (*b*) plugging of the vessel below with detached pieces of fibrin (c) diffusion or rupture

6 Finally death may occur from **cerebral embolism** or from pressure on vital structures in the neck and chest

Treatment —**General Treatment** is to be regarded as preliminary or accessory to operation, except when this is impracticable It is directed towards reduction of the blood pressure and increase of the clotting power of the blood. Complete rest must be insisted upon and all sources of mental anxiety removed. The bowels should be freely opened daily and potassium iodide (gr xv t d.s) and calcium lactate (gr v t.d.s) given by mouth Diet should be light and fluid intake restricted to one pint a day

Operative Treatment.—Many methods are now of historical interest only and these will be mentioned briefly

1 The obliterative endaneurysmorrhaphy of Matas is in theory the ideal procedure and indeed may be the only method available when ligature has failed and excision is impossible A tourniquet having been applied, the sac is exposed, opened along its free border and the clot shelled out The openings of *all* vessels entering or leaving the sac are firmly closed with silk sutures Any redundant folds of the sac are removed and the walls oversewn by successive layers of silk sutures so that the sac is replaced by a solid fibrous pad which obliterates the lumen of the parent vessel. The procedure may be difficult if not impossible in some cases of lobulated and extensive sacs, or dangerous if it entails a delicate dissection which may injure the collateral circulation Matas has suggested two modifications which are brilliant in conception but of doubtful practical value viz the conservative and the reconstructive endaneurysmorrhaphy in which an attempt is made to preserve or reform the lumen of the parent vessel.

2 Excision of the sac is an admirable method, except for one disadvantage the danger of injuring the nerves veins and collateral arteries which may lie in close contact with the sac It is the operation of choice in all aneurysms of small vessels *e.g* below the knee and the elbow

3 Ligature of the artery may be either proximal or distal and

either close to the sac or at a distance (*a*) Anel's proximal ligature is placed close to the sac so that no branches intervene between it and the ligature (*b*) Hunter's proximal ligature at a distance is so placed that one or more branches intervene and aims at a gradual reduction of the blood stream (*c*) Brasdor's distal ligature is placed as close to the sac as possible (*d*) Wardrop's distal ligatures are placed on the main branches of the affected vessel as in the case of an innominate aneurysm when the common carotid and subclavian arteries are tied (Fig 133)

4 The introduction of foreign bodies into the sac cannot be regarded as a satisfactory procedure Steel wire coils have been passed through a fine needle D Arcy Power and Colt employed an

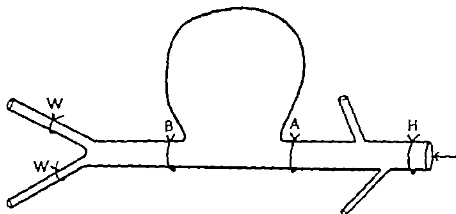


FIG. 133

Diagram illustrating the different types of ligature for saccular aneurysm of a large artery

H Hunter's; A, Anel's; B Brasdor's; and WW Wardrop's methods.

ingenious contrivance which could be collapsed into a small compass for introduction and then expanded into a spherical cage *in situ*

5 Electrolysis and acupuncture have found an occasional advocate for internal aneurysms but are really only of historical interest

6 Compression methods are obsolete except as a preliminary measure

7 Amputation will be called for in all cases of gangrene rupture, leakage and suppuration if other methods fail of secondary hæmorrhage and of erosion of bones and joints rendering the limb useless

It will be realised that Matas obliterative operation is the method of choice but it may be impracticable if the artery is the seat of degenerative as well as aneurysmal changes Excision is equally valuable if it can be done without injury to surrounding structures and especially to the collateral circulation The proximal ligature of Anel is satisfactory and will be practised as the routine procedure if radical methods appear too formidable Distal ligature is used only when other methods are impossible and is far from satisfactory

A leaking aneurysm demands urgent attention, the artery being tied immediately above the sac and if this fails to arrest the bleeding,

excision or Matas operation should be attempted An infected aneurysm also calls for energetic measures similar to the above but considerable anxiety remains till all danger of secondary hæmorrhage is past

Arteriovenous Aneurysms

These have been defined above (p 267) Two main types occur the aneurysmal varix and the varicose aneurysm

The Aneurysmal Varix is a direct communication between artery and vein without an intervening sac The veins are incapable of withstanding the arterial pressure and become dilated tortuous and varicose both above and below the opening The branches in the vicinity are so distended as to render the operative approach to the main vessels a formidable procedure The plexus of dilated veins

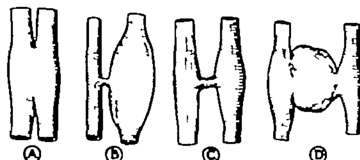


FIG. 134

Varieties of arteriovenous fistulæ

(*A*) Direct communication between artery and vein. (*B*) Aneurysmal varix. The vein is dilated evenly (C) Arteriovenous fistula united by a small fibrous canal. (D) Varicose aneurysm.

forms a pulsating swelling exhibiting a thrill on palpation which is continuous but accentuated with each heart beat The stethoscope distinguishes a loud murmur which also varies with the heart beat the noise being likened to the angry buzzing of bees in a paper bag or to the hum of machinery A systolic bruit is conducted distally in the artery and a diastolic bruit can be traced proximally in the vein for a considerable distance The former will be heard also at the cardiac apex and after some weeks the heart begins to dilate and hypertrophy Although the process is slow it is persistent and in time X rays will show a greatly enlarged heart The symptoms are dull aching pain in and swelling of the limb which lead to a reduction in working capacity by about 33 per cent

Treatment—Although the local conditions can be controlled by elastic support in many patients operation should be advised in every case in order to prevent dilatation of the heart The vessels are exposed the communication between them cut through and the walls of each carefully sutured If this is impracticable the artery and vein should be tied *above and below the opening* (the so-called quadruple ligature)

The Varicose Aneurysm differs from the varix by reason of the existence of a sac between the vessels through which blood passes from the artery to the vein. The sac is of the false aneurysmal type, the walls being composed of fibrous tissue The results and clinical features except for the presence of the pulsating sac are similar to those of the varix but whereas this latter may be present for years without serious inconvenience to the patient the varicose aneurysm enlarges rapidly and ends in diffusion or rupture Operation should be undertaken in every case, the ideal procedure being to expose and excise the sac the vessels being separately closed by lateral suture. This is rarely possible and the damaged area of both artery and vein should be resected. Fig 134 shows diagrammatically the difference between the types

Cirsoid aneurysm and aneurysm by anastomosis are described in the section on Angiomata (p 294)

Aneurysms of Individual Arteries

Aneurysm of the Thoracic Aorta is essentially a medical condition and comes within the scope of the surgeon only as a diagnostic problem



Fig. 135

An enormous aneurysm of the arch of the aorta, which has penetrated the chest wall.

(Fig 135) The signs and symptoms depend on the position of the sac and the structures involved by erosion or pressure The clinical picture is admirably set forth in Conybeare's Textbook of Medicine

Aneurysm of the Innominate Artery is rare fusiform and usually associated with a similar condition of the aortic arch It presents as a pulsating swelling behind the right sternomastoid muscle and may push the right sternoclavicular joint forward Symptoms are due to pressure and are (1) local pain if the sternum or clavicle is being eroded (2) referred pain in the distribution of the brachial plexus (3) muscular weakness in the right arm (4) swelling and œdema of the right arm and right side of the neck which swelling may involve the left side if the sac is pressing on the left innominate vein (5) dyspnœa and (6) dysphagia The signs will be (a) diminution in the right carotid and right radial pulses (b) contraction or dilatation of the right pupil due respectively to paralysis or stimulation of the sympathetic (c) sweating and flushing of the right side of the face (d) local signs of the tumour—an area of dulness pulsation bruit etc and (e) a characteristic shadow shown by radiography

Treatment consists in partial distal ligature at a distance (Wardrop s operation) Total ligature is impracticable because of the danger of cerebral anæmia The method of choice is the simultaneous ligature of the right common carotid and the third part of the right subclavian arteries The danger of hemiplegia is a very definite one but it has to be faced If untreated innominate aneurysms rupture either on the surface or into the mediastinum trachea or œsophagu

Aneurysm of the Common Carotid Artery is rare but among women it is the commonest of all even so it is more frequent in males than females and on the right than on the left side The dilatation is near either the bifurcation or on the right side its origin The intrinsic signs and symptoms of all aneurysms are present and the pressure symptoms are pain cough dyspnœa and those due to interference with the cerebral blood supply

Diagnosis from other aneurysms at the root of the neck may be difficult especially as dilatation of the aortic arch and of the innominate artery may be accompanied by dilatation of their branches Careful analysis of the symptoms and signs and radiography should lead to an exact diagnosis Pressure on the left recurrent laryngeal nerve is undoubted evidence of an aortic aneurysm pressure on the right recurrent nerve points to an aneurysm of the right subclavian or of the innominate Diminution of the radial pulse alone means a subclavian sac of the superficial temporal artery alone a common carotid sac of both temporal and radial on the right side an innominate aneurysm Tracheal Tug is said to be found in aortic lesions only None of these signs is infallible however as the sac of any one vessel may be large enough to press on others near at hand

Treatment of those near the bifurcation is proximal ligature and of those near the innominate artery distal ligature (Brasdor s operation) If untreated, they will finally rupture on the surface into the mediastinum or into the trachea or œsophagus

Aneurysms of the External Carotid and of the extracranial part of the **Internal Carotid** arteries are rare except as extensions from a dilatation of the common carotid artery near the bifurcation. The swelling is between the angle of the jaw and the thyroid cartilage

and the hypoglossal nerve pharynx and larynx may be pressed upon. The internal carotid aneurysm may project into the pharynx where it is seen as a swelling beneath the mucous membrane somewhat resembling a peritonsillar abscess Failure to differentiate the two is likely to be followed by the most disastrous consequences

Treatment —The sac of the external carotid aneurysm should be dissected out and excised if this is impossible an attempt should be made to apply a proximal ligature failing which the common carotid will have to be tied An internal carotid sac cannot be excised with safety and the common and external carotid vessels must be tied. If the external is not tied blood can flow down it into the sac and so render the operation futile. If untreated these sacs rupture on the surface or into the pharynx

Aneurysms of Intracranial Vessels occur in the internal carotids the basilar arteries and any of their main branches They are either congenital or due to syphilitic arteritis or the lodgment of emboli and the majority are symptomless until they rupture the patient then dying suddenly of apoplexy Occasionally they cause pain, signs of pressure on localised areas of the brain, and general signs of increased intracranial tension, *i e.* headache and vomiting Some patients are conscious of a pulsation inside their skulls or of a whizzing bruit Certain carotid aneurysms give the cavernous sinus syndrome due to pressure upon IV V and VI cranial nerves Diagnosis and accurate localisation is made by arteriography (p 002) The internal carotid on the affected side should be ligatured though the results are far from encouraging

Aneurysm of the Subclavian Artery —The first part is affected only on the right side and then in conjunction with an innominate aneurysm. The third part is sometimes affected in men from carrying heavy weights on their shoulders, and is therefore more common on the right side Women are rarely affected The dilatation tends to spread to the second part and the sac is frequently loculated, secondary sacs passing among the many recesses formed by the bones and muscles in this crowded region. The first symptom in many patients is pain in the hand, whilst later there will be muscular weakness and wasting anæsthesia and œdema of the arm The sac may compress the lung and pleura and cause hiccough from pressure on the phrenic nerve. A deep seated swelling will be found in the supraclavicular triangle

Treatment is both difficult and unsatisfactory Excision and Matas obliterative operation would give good results but for the difficulties due to the ramifications of the sac If the first part is not affected, ligature here is the most promising of all methods but if this is impossible the innominate artery must be tied and, in addition the common carotid in order to prevent back flow into the sac

Aneurysm of the Axillary Artery is usually traumatic in origin —penetrating wounds, fractures and dislocations or their reduction being the predisposing causes The condition is seen in men only and the right side is usually affected A very large sac forms rapidly and the clavicle and ribs may be eroded Symptoms are pain œdema

and loss of power in the upper extremity Rupture may occur on the surface or into the pleural cavity

Treatment is excision of the sac or failing this ligature of the third or second part of the subclavian as near to the sac as possible

Aneurysms of the Brachial, Radial, Ulnar and other arteries in the arm are traumatic and should be excised

Aneurysm of the Abdominal Aorta affects either that part from which the cœliac axis arises or the lower part near the bifurcation A swelling in the middle line is present accompanied by pain from erosion of the vertebræ œdema of the legs due to pressure on the inferior vena cava and some gastro-intestinal disturbance An X ray film will readily distinguish the true aneurysm from those conditions which transmit the pulsation of a normal aorta A few good results have been recorded of treatment by the introduction of coils of wire Aneurysms are occasionally seen in the renal splenic hepatic and mesenteric arteries

Iliac or Inguinal Aneurysms arise in the common and external iliac arteries or in the common femoral trunk. Owing to the density of the fascia of the thigh they tend to spread upwards towards the iliac fossa enlarging to great size eroding the ilium and even reaching the loin. Eventually they burst either diffusely on the surface or into the peritoneal cavity They are recognised by the typical pulsating swelling and pain and œdema in the leg The iliac sacs may be sufficiently deep-seated at first to escape notice and the pain down the front of the thigh may be diagnosed as rheumatism or neuritis

Treatment.—Excision is ideal but rarely practicable Proximal ligature as close to the sac as possible gives good results the external iliac being approached extra peritoneally and the common iliac by the transperitoneal route

Aneurysms of the Gluteal and Sciatic Arteries present pulsating swellings in the buttock and give rise to sciatica from pressure on the great sciatic nerve Diagnosis is difficult because of the depth of the swelling while a pulsating sarcoma of the bones of the pelvis may present a similar picture Treatment consists in a transperitoneal ligature of the internal iliac artery any attempt to secure the vessel from the buttock being certain to fail as the sac encroaches on the sacro-sciatic notch and may then enter the pelvis

Aneurysm of the Superficial Femoral Artery is traumatic in origin and appears either at the apex of Scarpa's triangle or in Hunter's canal and causes little disturbance to the limb

Treatment is excision

Aneurysm of the Popliteal Artery (Figs 136 and 137) is the commonest of all aneurysms in the limbs It may follow injury arterial degeneration or the lodgment of an embolus at the bifurcation It is almost always seen in men and may be bilateral. The early symptoms are pain and stiffness in the knee hence the diagnosis is likely to be chronic rheumatism or osteo-arthritis The knee is held semi flexed and a pulsating swelling occupies the popliteal space If the sac extends forwards the bones and joint capsule are eroded and severe pain and derangement of the joint results if it spreads backwards

the leg is swollen, weak and painful, and gangrene is likely to supervene because both the veins and the vessels of the collateral circulation are compressed. There should be no difficulty in diagnosis if the leg is efficiently examined.

Treatment—Excision should never be practised because of the danger of injury to nerves veins and arterial collaterals Matas operation is excellent if it can be done but in many cases the method of choice will be the classical Hunterian ligature in the canal.



FIG 136
An irregular fusiform aneurysm of the popliteal artery



FIG 137
A saccular aneurysm of the popliteal artery completely thrombosed.

Aneurysms below the knee are invariably traumatic and are easily cured by excision.

PULSATING EXOPHTHALMOS

This condition is so frequently due to aneurysmal conditions that it is most conveniently described here The causes are (1) a cavernous angioma behind the eye (2) aneurysms of the ophthalmic or internal carotid artery (intracranial part) (3) a cirsoid aneurysm (4) cavernous sinus thrombosis (5) an aneurysmal varix between the internal carotid artery and the cavernous sinus and (6) a pulsating sarcoma of the orbit It is frequently traumatic in origin and follows a fractured base of the skull which has damaged the region of the cavernous sinus. The eye is displaced forward, the conjunctival and retinal vessels are congested, and the whole globe appears

œdematous Corneal ulcers form movements of the globe are restricted and vision is impaired The patient complains of great pain and a feeling of tension in the orbit and is conscious of a rushing sound The stethoscope detects a continuous bruit loud and musical comparable to the bee in the-paper bag murmur of arteriovenous aneurysms Compression of the common carotid artery produces a marked mitigation of symptoms and ligature of the internal carotid artery should be performed

THROMBOSIS AND EMBOLISM

Thrombosis

Thrombosis is intravascular clotting of the blood which may



Fig. 139

Red thrombus from the common iliac vein and its main branches, from a patient who died suddenly of a pulmonary embolism.



Fig. 140

Thrombosed varicose veins.

take place in the chambers of the heart the arteries capillaries and veins particularly the last named Predisposing causes are (*a*) damage to the endothelium by injury inflammation or degeneration (*b*) increased coagulability of the blood due to infection or toxæmia and (*c*) slowing or arrest of the blood stream The clot may be of two kinds. A *White Thrombus* is the result of slow deposition of successive layers of fibrin and leucocytes the best example being the whitish grey laminated clot in a sacciaar aneurysm Rapid coagulation in a

stagnant blood stream produces a *Red Thrombus* in which all the constituents of the blood are included (Fig 138) This is found in a thrombosed varicose vein (Fig 139) and in a vessel after ligature. White clot is firmly adherent to the wall of the vessel but red clot is usually quite loose

Results of Thrombosis in a Vein A Local.—(*a*) If the clot is sterile it may gradually become organised into connective tissue and the vein converted into a fibrous cord. Secondly the clot may be attached to one side of the vessel only and gradual shrinkage towards its fixed point lead to re-establishment of the blood flow in the vein. Thirdly organisation may stop short of fibrosis owing to canalisation of the clot by dilatation of the small vascular channels within it so that in this way also the lumen is reconstructed. Lastly a small clot fixed to one side of the vessel may become calcified to form the phlebolith which is so commonly seen in X ray films of the pelvis where it may be mistaken for a ureteric calculus



Fig 140

A septic thrombus in the aorta

(*b*) If the clot is infected no organisation occurs but softening and suppuration lead to abscess formation at first in the vein and later outside it (see Phlebitis, p 288)

B At a Distance —(*a*) The distal area drained by the thrombosed vein becomes congested and swollen unless the affected vessel is small and the collateral circulation good Blocking of the main vein of a limb leads to great swelling of the whole limb which is white and pits deeply on pressure The œdema persists for many weeks and may never clear up completely Thrombosis of the inferior vena cava if it does not prove fatal results in an enormous dilatation of the collateral circulation hugely dilated veins being seen beneath the skin running from the groin to the axilla (*b*) On the proximal side the thrombus may remain stationary may gradually extend upwards by further deposition of clot so reaching and involving larger trunks or may shed pieces which are swept away in the blood stream as emboli

Arterial Thrombosis is not common (Fig 140) It is followed by an opening up of the collateral circulation and gangrene is not likely to follow as the obstruction is of gradual onset

EMBOLISM

Embolism is the name given to the condition in which a solid or semi-solid foreign substance is swept along in the blood stream finally to become impacted in a vessel which is no longer large enough to let it pass on As the veins of the systemic circulation steadily increase in size on their way to the heart emboli obviously can never lodge in them They are therefore found only in arteries and in the portal venous system An embolus may consist of (1) a sterile clot derived from a thrombus (2) an infected clot from a septic focus (3) fibrinous vegetations from the cardiac valves or atheromatous plaques (4) clusters of malignant cells in carcinoma or sarcoma ( ) globules of fat (6) bubbles of air and (7) parasites as in hydatid or filarial diseases

Results of Embolism.—As soon as the embolus comes to rest fibrin is deposited on it and the obstruction of the vessel rapidly becomes complete The results depend on the size and situation of the vessel blocked the importance and delicacy of the tissues supplied the size of the embolus and whether it is sterile or infected The effects are as follows —

1 TRANSIENT ANÆMIA —If the vessel is small, the capillary anastomosis free and the structures supplied unimportant a transient anæmia occurs without any appreciable symptoms If the tissues supplied are very delicate and unable to withstand temporary loss of nutrition, function may be lost even if the cells themselves do not die *e.g* the blindness which follows embolism of the central artery of the retina

2. GANGRENE of a limb or of part of the intestinal tract may follow blockage of the main vessel at a point where the collateral circulation is ineffective Sudden intense pain is felt at the time of lodgment of the embolus and gangrene appears later

3 INFARCTION occurs in certain organs the arteries of which are end arteries (*i.e* vessels whose capillaries have no anastomosis with those of adjacent vessels) viz. the lungs kidneys spleen and brain. An infarcted area is usually wedge or cone shaped, having the occluded artery at its apex In a white infarct the pattern and texture of the organ are no longer visible and a white homogeneous area results A "hæmorrhagic infarct is purple in colour owing to the presence of extravasated blood Small uninfected infarcts become organised and converted into puckered scars except in the brain where softening occurs

Embolism in Certain Organs produces symptoms of such grave importance that they are described separately

1 IN THE LUNGS —Pulmonary embolism is usually seen as a complication of operations in the abdomen pelvis or lower extremities The thrombus probably forms in the veins of the calf muscles and spreads thence to the femoral and iliac veins The initiating factor is possibly pressure upon the calf during anaesthesia and contributing to it are low-grade sepsis and a slowing up of the blood stream due to enforced rest in bed. The embolus may be so large that one of the

main branches of the pulmonary artery is blocked and death is instantaneous or the detached fragments of clot may be so small that the effects are trivial between these two extremes is a wide range of cases of varying severity The very severe and the fatal cases occur one to three weeks after operation usually from some movement in bed or on the first occasion that the patient gets out of bed. The symptoms are a sudden violent pain in the chest a look in the face of anxiety amounting almost to terror gasping struggling respirations and cyanosis. Death may occur so suddenly that a patient apparently well on the way to recovery falls back dead in the nurse s or doctor s arms, or survives for a few minutes or a few hours The symptoms in the non fatal cases vary greatly in degree There is a sudden stab of pain in the chest dyspnoea general distress and anxiety and after a few hours some blood-stained sputum is coughed up The condition is then one of pleuropneumonia and the severity of the subsequent illness will depend on the size of the affected area of lung

Treatment—Considerably more attention should be given to the prevention of this tragic complication Patients are so often kept in bed *unnecessarily long* and are *overwhelmed with instructions* to be still and not move about in bed. Retention in bed should be restricted to the minimum and patients encouraged to move about in bed as soon as and as much as their local or general condition permits. In our surgical wards at St Mary s Hospital a masseuse attends twice daily and conducts exercise sessions in which all patients must join except those certified as being too ill Deep breathing exercises, movements of fingers and toes arms and legs quadriceps drill etc., are practised by numbers At its inception this was received with suspicion and some hostility by all concerned as an innovation of doubtful propriety To-day its value is established and its most ardent supporters are the sisters of our wards and nurses trained therein The occurrence of pulmonary embolism to-day would call for serious inquiry Pressure on the calf and groins should be avoided and whenever possible splints should be so counterbalanced by pulleys and weights as to allow movements of the patient without interference with the immobilisation of a fracture Lastly massage of the lower limbs and the abdomen should be started as soon as possible after operation. Once the presence of thrombosis in the calf has been recognised and the clinical picture suggests the extension of thrombosis the propriety of ligaturing the common femoral vein should be considered Trendelenburg s operation of embolectomy i e. removal of the clot from the pulmonary artery cannot yet be considered to have emerged from the experimental stage The use of anticoagulants is described below (p 289)

2 IN THE BRAIN the middle cerebral artery is blocked and complete hemiplegia results but although some permanent impairment of function persists the degree of recovery is often surprisingly good An aneurysm may form later at the site of impaction of the embolus

3 Embolism of the CENTRAL ARTERY OF THE RETINA produces sudden complete permanent blindness in spite of the fact that the retinal cells appear to retain their vitality

4 In the liver emboli are usually septic and come from some part of the area drained by the portal system The condition of Pylephlebitis is described on p 717

5 Embolism of the mesenteric vessels leads to one form of acute intestinal obstruction (p 670)

6 In the limbs the embolus usually lodges at the bifurcation of the main vessels e.g at the termination of the popliteal artery The symptoms are sudden agonising pain below the site of impaction tenderness at this point and coldness numbness loss of power and loss of distal pulse in the limb If the patient is seen within twelve hours of the impaction of the embolus the artery should be exposed opened longitudinally and the clot removed The vessel wall is sutured with vaselinised silk with the utmost care The results of this operation of peripheral embolectomy are distinctly encouraging If *this operation is not done gangrene will follow in almost every case* though recovery is not impossible I have now removed one saddle-shaped clot from the bifurcation of the aorta one clot from each common iliac artery in the same patient and a clot from five common femoral vessels In all except the second case gangrene was averted Success largely depends upon the time factor not a moment must be wasted in transferring a patient to an operating theatre The best results will be seen in those patients who are operated upon within four hours

7 In the spleen and kidney embolism causes pain swelling and a slight rise of temperature In the kidney there will be a slight transient hæmaturia

INJURIES AND DISEASES OF THE VEINS

Injuries of Veins

Subcutaneous Rupture of a vein is commonly seen in association with fractures dislocations and severe contusions while varicose veins may rupture subcutaneously from quite trivial blows Although the vein walls do not curl up and retract in the same manner as the intima of an artery the blood pressure is so much lower that the extravasated blood quickly compresses the vein and arrests the bleeding When a large vein is injured there will be some local swelling and œdema of the limb but the swelling does not pulsate and the distal pulse is not weakened

Treatment consists in firm bandaging and in the case of a large vein, elevation of the limb for a week.

Wounds of Veins are very common as the result of penetrating injuries and of surgical operations Small veins readily collapse and bleed *little* but hæmorrhage may be profuse from the larger veins especially if they are diseased or if they are injured where passing through a layer of fascia which prevents them from collapsing *Venous hæmorrhage is a continuous steady welling up of dark blood which is easily controlled by light pressure* Wounds of the *lateral wall of* a vein should be closed by a lateral ligature a vaselinised thread

3. Post-operative thrombosis. As we have seen on p 283 almost any operation may be followed by intravascular clotting and it is hardly practicable to give heparin as a routine. But if immediately after the lodgment of a small embolus heparin is administered it is possible that further emboli may be prevented
4. Constant drip saline and blood infusions may be kept in action for many days without clot forming in the cannula.

INFECTIVE PHLEBITIS is the more serious but less common type The preliminary changes are the same as in the simple variety but the clot is infected and slowly breaks down to form dirty greyish pus and the thrombus spreads more extensively both up and down the vein The inflammation affects the tissues round the vein and an infective periphlebitis follows Finally an abscess forms primarily inside the vein but later spreading outside it Small pieces of disintegrating clot are likely to be detached and septic emboli thrown off into the blood stream.

Symptoms—The picture of simple phlebitis rapidly changes with the advent of infection The patient becomes gravely ill with rigors and a high temperature of 103° to 105 F the local condition becomes more extensive and less circumscribed and diffuse suppuration occurs.

Treatment.—The pus must be evacuated by suitable incisions and if there is an extensive area of periphlebitis this must be laid open and drained. If septic emboli are being set free the vein should be ligated on the proximal side, *e.g* lateral sinus thrombosis (p 401) but this can only be done if a *single* venous trunk is affected. If several veins in a limb are affected, and if treatment does not put an end to the shower of emboli amputation will have to be considered as a life-saving measure. Chemotherapy is of course essential.

VARICOSE VEINS

A Varicose Vein is one which has become permanently dilated lengthened and tortuous This condition may affect the whole length of a vein or only small isolated patches and although theoretically any vein is liable to varicosity yet in practice only the veins of the thigh and leg the spermatic cord the ano-rectal region and the lower end of the œsophagus are involved. Varicoceles are described on p 848 and hæmorrhoids on p 685 The œsophageal varices occur only in cirrhosis of the liver The following description applies to varicose veins of the legs

Etiology—Varicose veins are rarely seen before the age of 15 years, but afterwards they are very common in both sexes and at all ages. Women are affected more than men because of the frequency of the condition in pregnancy *The exact causation is unknown but there are many contributory factors*

1 Congenital defects *e.g* weakness of the vein wall absence or incompetence of valves or over-development of the cribriform fascia in the region of the saphenous opening The theory of congenital predisposition is upheld by the varix which appears in youth affects many members of the same family and often the same part of the same vein in that family

2 Prolonged standing Waitresses are particularly liable to the condition

3 Obstruction to the vein Tight elastic bands e.g garters in men and the lower end of knickers in women produce persistent distension of the veins so also may the pregnant uterus and other abdominal or pelvic tumours

4 Obstruction to the deep vein leads to a compensatory dilatation of the superficial veins e.g in the white leg of the puerperium and in typhoid thrombosis

5 Arteriovenous aneurysms cause varicosity of the veins

6 Rupture of the valves may occur in athletes and accounts for the frequency of varicose veins in an unexpected group of people

7 The internal saphenous vein contains a long column of blood flowing against gravity As soon as the valves cease to function properly a vicious circle is formed and the varicosity rapidly increases in size and extent

Pathology — A varicose vein is thickened tortuous and brittle When cut across it remains cylindrical and does not collapse The thickening is irregular and patchy and weak spots are left through which thin walled pouches project forming little varices on the main varicose vein. One such secondary varix may occur at the upper end of the internal saphenous vein near the saphenous opening and if it reaches an appreciable size it is called a saphenous varix. *Microscopically the vein has* lost most of its muscle fibres which are replaced by fibrous tissue



FIG. 141

One single large varicose vein below the knee. An enlarged pre-patellar bursa is also present.

Symptoms of uncomplicated varicose veins are dull aching pains in the leg *below the knee with or without swelling at the ankles The en*larged veins can be seen beneath the skin (Fig 141) their extent prominence and tortuosity varying widely in different patients In long-standing cases there may be such thickening of the skin and subcutaneous tissues that the veins are not obvious but can easily be felt as *grooves or gutters A venous thrill can always* be felt in a saphenous varix and for some distance below it Trendelenburg s test is of some importance When the patient lies down and the limb is elevated the veins empty The internal saphenous vein near the opening is then firmly compressed and the patient asked to stand up when blood will slowly fill the veins from below upwards When the pressure is released a sudden rush of

blood from above to fill the veins below is clear evidence that the valves are faulty

Treatment.—A **Palliative Treatment** consists in the removal of any cause of obstruction the application of a crêpe velpeau bandage, or of an accurately fitted elastic stocking These stockings are expensive, they need to be renewed twice a year and patients find them hot and irksome No patient should be refused injection unless the general condition renders it inadvisable or there is ground for belief that it will not prove of much value

B **By Injection.**—The obliteration of the lumen of the vein by the injection of irritant drugs is now the established method of treatment with or without ligature The only contraindications are the occlusion of the deep veins by previous thrombophlebitis, and such indifferent general health as to make injection inexpedient or unsafe Many substances have been used, but the following are established as being the most efficacious Sodium salicylate in 20 30 and 40 per cent solutions sodium morrhuate in 5 and 10 per cent. solutions quinine and urethrane and lithium salicylate (30 per cent.) Sodium salicylate has the disadvantage of being painful but all give excellent results. The patient lies on a couch (there being no need whatsoever for him or her to be standing up) and if the veins are NOT prominent a band is placed round the leg A very fine hypodermic needle (No 18 or 20) is inserted into the vein The beginner will be well advised to withdraw a little blood into the syringe to satisfy himself that the needle is in the lumen of the vein The band is removed, the vein emptied of blood and the injection made The length of vein affected by each injection varies considerably but a reaction of 2 to 8 in. may be expected. No estimate of the number of treatments required should be given until the result of the first has been seen If any solution leaks into the subcutaneous tissues pain is felt and sloughing may follow After the injection a small pad of sterile gauze is firmly bandaged or strapped into position and worn for six hours There is no need for patients to lie up but on the contrary they should be encouraged to continue their daily occupation at once The effects of the injection are as follows within six hours the injected vein becomes painful and tender in a varying length and on the following morning it is thickened and the overlying skin may be red and hot The pain redness heat and tenderness wear off in a few days but the thickening remains for six to eight weeks during which time the thrombus is organising until finally nothing remains but a fibrous cord It is important that patients should be forewarned of this sequence of events lest they imagine the treatment has taken an unexpected course or has failed

C **Operative.**—If a saphenous varix is present if the vein is greatly dilated in the thigh if a thrill on coughing can be felt in the varices below the knee and if Trendelenburg's test is positive the internal saphenous vein must be ligated It is exposed at its junction with the common femoral vein and ½ in. of it removed between two ligatures It is essential that the proximal catgut strand should be placed as near to the main vein as safety permits and that the three tributaries of the superficial vein be tied also

In a small number of patients the external saphenous vein will be dilated and a similar ligature operation will be needed at its junction with the popliteal vein

Complications — *A* **Pigmentation of the skin** is seen in most cases of long standing It is due to deposition of blood pigment

B **Varicose eczema** *is preceded by pigmentation and is* due to stasis of blood in the skin combined with the chronic irritation of dirt or clothing It may readily pass into—

C **Varicose ulcer** described on p 167

D **Thrombophlebitis** is very common in varicose veins and may follow minor injury

E **Hæmorrhage** results from spontaneous rupture injury or ulceration Profuse bleeding occurs from *both* ends of the vein and shows no signs of ceasing as the thickened vein does not collapse It may prove fatal if the patient is intoxicated and no help is at hand It can be controlled by simple pressure over the bleeding points and by elevation of the leg

F **Recurrence** Experience has shown that the anastomosis between the superficial and deep venous systems in the lower extremity are more extensive than was generally believed. For these reasons no method of treatment can be expected to guarantee permanent cure

TUMOURS OF THE BLOOD VESSELS

The tumours arising from the blood vessels are known as Hæmangiomata and are of four varieties

Capillary Hæmangioma (or Telangiectasis) is usually a congenital growth of tubular capillary vessels containing blood. They are of unequal size and have a very delicate endothelial lining supported by a fine fibrous stroma They constitute the different types of birth marks or nævi which are seen chiefly in the neck, face and hands The spider nævus occurs on the face as a bright red central point of capillaries from which spread fine red radiating lines The strawberry" and port wine stain nævi may reach large size and affect a considerable area of skin The tumour is not raised above the surface and is a deep purple or violet colour They are sometimes associated with other tumours of the skin such as the pigmented hairy mole and the cavernous angioma. They are also found in mucous membranes and in muscle

Treatment —Some nævi are readily destroyed by the application of CO_2 snow the galvanic cautery electrolysis or radium The large ones are best left alone as their destruction may lead to scarring, which is even more disfiguring than the original nævus Occasionally excision and skin grafting may be required.

Cavernous Hæmangioma occurs either as a congenital malformation in the subcutaneous tissue (Fig 142) or as an acquired growth in an internal organ, *e.g* the liver Its walls are thicker than those of the capillary nævus large blood spaces are formed in it and it is altogether a more fleshy tumour In the subcutaneous tissues it forms a soft vascular swelling blue in colour (Fig 143) which can be reduced in size by pressing the blood out of it while it

returns to its normal size when the compression is removed. Occasionally its surface becomes infected and it forms a rapidly growing fungating tumour (Fig 144) In the liver it usually remains undiscovered except in the post-mortem room



FIG. 142
Large hæmangioma from the subcutaneous tissues of the thigh.

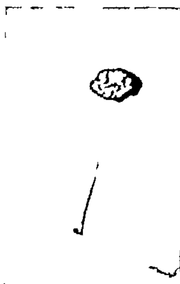


FIG. 143
Hæmangioma on the back of a small child.

Treatment is excision cauterisation or injection with a sclerosing solution

Plexiform Angioma is one in which the main bulk of the tumour is composed of arteries There are two varieties

1 THE CIRSOID ANEURYSM is most commonly encountered in the temporal region of the scalp It may follow injury develop from a pre-existing cavernous hæmangioma or arise spontaneously Large tortuous pulsating arterial channels can be seen beneath the skin. It is soft compressible and the component vessels are easily felt. There will be a thrill and a systolic bruit while the patient complains of a loud continuous rushing or roaring sound.



FIG. 144
An infected hæmangioma.

Treatment is far from satisfactory The ideal procedure would be total excision combined with ligature of all the vessels that feed the tumour but this is usually impracticable Bilateral ligature of the external carotid arteries may have to be tried

2 THE ANEURYSM BY ANASTOMOSIS consists of much smaller arteries together with veins and capillaries It occurs in the scalp neck and upper extremity and one form is found in the interior of bones in which it may closely mimic a pulsating sarcoma

Treatment is by excision electrolysis or radium

Glomangioma.—This rare tumour arises from a normal glomus (Fig 145) which is a direct communication between arteriole and venule occurring in the subcutaneous tissues principally in the terminal segments of fingers and toes Its function is in the nature of a shunt or short circuit and is concerned with regulation of temperature

This tumour is composed of a plexiform mass of vessels surrounded

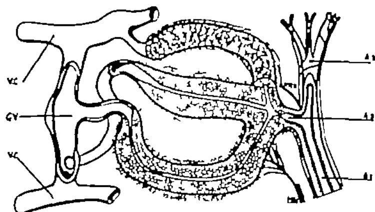


FIG. 145

Normal glomus A1 arterioles to capillaries; A2 glomal artery; A3, small artery to skin; V C., collecting veins; G V., glomal vein; M.n., myelinated nerves; N.m.n., non myelinated nerves. (*After Masson*)

by a well-defined capsule They are lined by a single layer of endothelial cells and their walls consist of a thick coat of glomus cells and smooth muscle Numerous nerve fibres both myelinated and non myelinated can be seen.

Clinically they are quite small (from 3 mm to 3 cm) of a blue or purple colour and at first sight suggest a blood blister Some of them can be emptied by pressure Subungual tumours are likely to betray their presence by a faint tinge of cyanosis showing through the nail Pain and exquisite tenderness are the outstanding symptoms

Treatment consists in excision

R M HANDFIELD-JONES

returns to its normal size when the compression is removed. Occasionally its surface becomes infected and it forms a rapidly growing fungating tumour (Fig 144) In the liver it usually remains undiscovered except in the post-mortem room



FIG 142

Large hæmangioma from the subcutaneous tissues of the thigh.



FIG. 143

Hæmangioma on the back of a small child.

Treatment is excision cauterisation or injection with a sclerosing solution

Plexiform Angioma is one in which the main bulk of the tumour is composed of arteries There are two varieties.



FIG. 144

An infected hæm angioma.

1 THE CIRSOID ANEURYSM is most commonly encountered in the temporal region of the scalp. It may follow injury develop from a pre-existing cavernous hæmangioma or arise spontaneously Large tortuous pulsating arterial channels can be seen beneath the skin. It is soft compressible and the component vessels are easily felt. There will be a thrill and a systolic bruit, while the patient complains of a loud continuous rushing or roaring sound

Treatment is far from satisfactory The ideal procedure would be total excision combined with ligature of all the vessels that feed the tumour but this is usually impracticable Bilateral ligature of the external carotid arteries may have to be tried.

2 THE ANEURYSM BY ANASTOMOSIS consists of much smaller arteries together with veins and capillaries It occurs in the scalp neck and upper extremity and one form is found in the interior of bones in which it may closely mimic a pulsating sarcoma

Treatment is by excision electrolysis or radium

Glomangioma.—This rare tumour arises from a normal glomus (Fig 145) which is a direct communication between arteriole and venule occurring in the subcutaneous tissues principally in the terminal segments of fingers and toes Its function is in the nature of a shunt or short circuit and is concerned with regulation of temperature

This tumour is composed of a plexiform mass of vessels surrounded

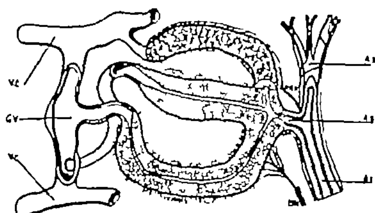


Fig 145

Normal glomus A1 arterioles to capillaries; A2, glomal artery; A3, small artery t skin; V.C., collecting veins; G V., glomal vein; M.n., myelinated nerves; N.m.n., non myelinated nerves. (After Masson)

by a well-defined capsule They are lined by a single layer of endothelial cells and their walls consist of a thick coat of glomus cells and smooth muscle Numerous nerve fibres, both myelinated and non myelinated can be seen

Clinically they are quite small (from 3 mm. to 3 cm) of a blue or purple colour and at first sight suggest a blood blister Some of them can be emptied by pressure Subungual tumours are likely to betray their presence by a faint tinge of cyanosis showing through the nail. Pain and exquisite tenderness are the outstanding symptoms

Treatment consists in excision

R M Handfield-Jones

CHAPTER XVI

THE DISEASES OF THE LYMPHATIC SYSTEM

THE LYMPHATIC VESSELS

Injuries to the Thoracic Duct

The thoracic duct opens into the junction of the left subclavian and internal jugular veins or into either of them just distal to their union. The duct usually divides into several small channels before reaching its termination so that a wound close to the veins is more likely to involve one of the terminal branches than the main duct itself. Injuries to the duct in the neck occur during operations in the supraclavicular triangle as a result of gunshot and stab wounds and rarely as a complication of a fracture of the clavicle. If the wound is recognised during the operation, a little spurt of chyle will be seen with each expiration but usually it remains unsuspected until the subsequent dressings are found saturated with chyle or until a fluctuant swelling appears beneath the healing skin incision. The divided duct should be ligated if possible failing which the wound must be packed with gauze even if the main duct is ligated little anxiety need be felt, as the intrathoracic anastomoses with other lymph channels will ensure adequate drainage

The thoracic duct may be injured in the thorax by a fracture of the spine penetrating wounds or by crushing accidents and the chyle may flow into the pleural cavity (chylo thorax) In the abdomen the receptaculum chyli may be injured by crushes or penetrating wounds or may rupture spontaneously from over-distension if the duct is obstructed by the pressure of growths or masses of glands in the mediastinum In such cases chyle collects in the peritoneal cavity (chylous ascites) and may appear in the urine (chyluria)

The right lymphatic duct may be injured in the right supra clavicular triangle but little trouble results and if a fistula does form it heals rapidly Extensive removal of glands from any area may be followed by a flow of lymph which delays the healing of the wound until in about four weeks time new lymphatic vessels are formed.

Lymphangitis

Acute Lymphangitis is most commonly seen as the result of infections of the fingers or the foot It is fully described on p. 230.

Chronic Lymphangitis may follow the imperfect resolution of an acute attack, but is usually a specific condition either tuberculous, syphilitic or very rarely in human beings, due to glanders.

TUBERCULOUS LYMPHANGITIS occurs in the vessels of the mesentery lung and upper extremity In the arm the infection starts from a primary focus in the hand—often so small as to escape recognition—and spreads up the vessels as an ascending lymphangitis The affected vessels become thickened nodular swellings appear at the site of the valves and eventually the nearest group of glands is involved The nodules are firm and solid at first but slowly soften and become adherent to the skin which finally breaks down to form a tuberculous ulcer

Treatment consists in excision of the primary focus of every nodule and of the affected group of glands The thickened lips in tuberculous children are due to a similar condition the lymphatics being infected from labial cracks and fissures

SYPHILITIC LYMPHANGITIS affects the vessels along the dorsum of the penis by extension from the primary sore In well marked cases an indurated cord can be traced from the sore to the enlarged glands in the groin

Chronic Non specific Lymphangitis.—I have recorded a curious condition affecting the fingers and hand which I believe to be of this nature It is typified by the following patient Some years ago artificial flowers and leaves of glass were fashionable and many beautiful examples were placed upon the market A lady having purchased some of these treasured them sufficiently to dust and clean them herself One day when thus engaged she cut her index finger slightly and thought nothing of it The edges of the leaves were sharp and the various colours obtained by paint or dye A week later the finger began to swell and ache gradually the whole digit enlarged It was seven weeks later that I was asked to see her and during this time the swelling had varied considerably first improving and then relapsing On examination the right index was symmetrically enlarged but little swelling appeared either on the dorsum or between the contiguous fingers She complained of slight aching and restricted movement No signs of acute inflammation were present the digit being cold, blue and mottled The scar was soundly healed but showed slight yet unmistakable pigmentation The patient was about to leave for a long sea voyage so that no treatment could be advised at that time Four months later she returned when the finger was less swollen but not normal Several weeks of physical treatment passed before recovery was complete

LYMPHANGIOMA

The processes underlying the formation of tumours of lymphatic origin are so obscure that it is impossible to differentiate with any certainty between the true lymphatic growths of new formation (lymphangiomata) and those swellings which are dilatations of normally existing channels (lymphangiectases) Three types of lymphangioma are described

Capillary Lymphangioma or lymphatic nævus is congenital in origin and occurs in the tongue lip and skin In the tongue and

lips it is red in the skin yellowish brown, and it may be papillary If any treatment is needed it can be destroy diathermy

Cavernous Lymphangioma is comparable to the cavernous hæ gioma and consists of thick walled spaces lined with prolifera endothelial cells It accounts for one type of macroglossia and ma cheilia which are congenital enlargements of the tongue and lips. is also seen in the skin and if any of the surface vesicles rupt lymphorrhoea will result

Treatment is excision if possible One very extensive type cavernous lymphangioma is occasionally seen in the neck of infants and may reach from the lower jaw to the clavicles It is congenital in origin and consists of cysts of varying size embedded in fibrous tissue. It is rarely possible to remove as it sends processes among the muscles and tissue planes of the neck, and a fatal issue is to be expected.

Cystic Lymphangioma occurs as a unilocular or multilocular cyst in the lower part of the neck and in the axilla It is congenital in origin and is found in children under the age of ten years as a soft, flabby lobulated swelling subject to recurrent attacks of mild inflammation which cause it to become more tense somewhat painful and tender and may lead to spontaneous cure In the quiescent period there are no symptoms

Treatment consists in removal.

LYMPHATIC OBSTRUCTION

Obstruction of lymph vessels will cause œdema of varying degree but in many cases where this is extensive it may be difficult if not impossible to determine the relative proportion of lymphatic and venous obstruction. As a general rule the collateral anastomosis of the lymph vessels is so extensive that even the removal of large groups of glands or the obstruction of a wide field of lymph vessels may not be followed by lymphatic œdema To produce this there must be blockage both of the collateral and main channels Examples of lymphatic œdema are (1) the rare solid œdema of the legs of developmental origin (Milroy's disease) (2) that following acute lymphangitis of the hand and forearm, (3) a rare result of facial erysipelas and of multiple gummata of the leg (4) blockage by carcinoma cells is best exemplified by Brawny Arm a late complication of carcinoma of the breast

ELEPHANTIASIS

Elephantiasis is a hypertrophic condition of the skin and sub cutaneous tissues following prolonged lymphatic obstruction Th parts usually affected are the legs thighs scrotum penis and vul and occasionally the breast face and arms Th skin and subcutaneo tissues become swollen from solid [illegible] does not pit on pressure Later a diffuse [illegible] skin [illegible] greatly

thickened and coarse Warty outgrowths and lymph vesicles appear on the surface and a profuse lymphorrhoea may result from rupture of the latter The leathery skin is liable to fissuring ulceration and recurrent attacks of lymphangitis There are two types of elephantiasis

The Filarial Type—Elephantiasis Arabum is seen in Barbadoes the West Indies China Japan Malay States India and South America and is due to obstruction of the lymphatics of the inguinal region by the worm *Filaria Sanguinis Hominis* The infection is transmitted by a mosquito (*Culex fatigans*) in which the intermediate stage of the life history of the worm is passed The ova reach the human stomach in drinking water penetrate the gastric mucosa and enter the lymph vessels The female worm settles in the inguinal lymphatics and gives rise to countless embryos which either block the lymph vessels or enter the blood stream in which they may be seen under the microscope during the day (*F diurna*) or the night (*F nocturna*) A patient thus infected will pass on these embryos to the mosquito which bites him and in this way the cycle is complete The overgrowth of the skin may be enormous the scrotum especially being so affected that it may rest on the ground when the man is seated on a chair (Fig 146)



Fig 146
Elephantiasis involving the scrotum and lower extremities of a native of India.

The Non-filarial Type includes all those cases of skin hypertrophy which follow any of the above mentioned causes of lymphatic obstruction. There is also a type which is indistinguishable from the filarial except that the parasites are not present and no cause can be found although there are grounds for believing that some may be due to a low grade streptococcal infection The author has had eleven cases of this type all in women six of whom lived in seaport towns in the South of England and in whom the legs were affected to varying degrees (Fig 147)

Treatment is most unsatisfactory If the lymph vessels containing the parent worms can be identified they should be excised If the disease is limited to the scrotum this should be amputated Sampson Handley s method of making strands of silk act as artificial lymphatics (lymphangioplasty) has had some success in cases of brawny arm but none in the lower extremity Kondoleon s operation consists in the excision of elliptical portions of skin subcutaneous tissue and

deep fascia from the outer and inner aspects of the thigh and leg It has had some successes and as many disappointments



Fig 147
Non-filarial elephantiasis.

THE LYMPHATIC GLANDS

Acute Lymphadenitis

Acute inflammation of a lymphatic gland is due to its infection with pyogenic organisms carried to it by the lymph vessels from a septic focus within its drainage zone Staphylococci and streptococci are the usual invaders, and as they gain entrance from the outside the primary focus is in the skin, subcutaneous tissues or mucous membranes of the upper air passages and mouth Such a focus can usually be identified but at times this may not be possible either because it has already subsided or because it is too small The lesions which give rise to acute lymphadenitis are not very serious as a rule for the grave deep-seated and spreading infections such as gangrene and cellulitis do not affect the glands. If the primary focus clears up rapidly and the patient's general resistance is good, resolution will occur without suppuration, but the tendency is for the glands to soften and break down. The inflammation will then spread to the periglandular tissues and the glands become matted together and in some unusually virulent infections periglandular suppuration may occur leading to a diffuse spreading cellulitis It has been noticed that lymph glands may swell up and suppurate after an injury which has not produced any abrasion or entry for sepsis to account for the adenitis it is assumed that organisms may be latent in the gland and be stimulated into activity by injury

Symptoms vary with the severity of the infection The primary focus may or may not be identifiable the intervening lymph vessels may be the seat of a typical lymphangitis or the glandular swelling may be independent of either The glands rapidly become enlarged, painful and tender and if they are superficial the skin over them is red hot and œdematous and the surrounding tissues will be infiltrated. Many of these infections subside without suppuration, but in others the swelling becomes soft in the centre and an abscess forms The local pain tenderness and infiltration increase and the patient becomes progressively ill with a raised temperature and severe malaise.

Treatment —The primary focus must be sought for and suitably treated Local treatment includes antiphlogistine poultices radiant heat baths and short wave therapy and when suppuration occurs an incision must be made and drains btained The organism will be cultured for penicillin and sulpl nsitivity and chemotherapy instituted in suitabl

Acute Cervical outh jaws, tonsils

pharynx and teeth when the upper deep cervical group will be affected It also results from sepsis of the scalp (e g pediculosis) the face (e.g impetigo) and the lips when the superficial cervical group is inflamed Incisions should follow the skin creases and cut across the fibres of the platysma muscle

A specific variety known as Glandular Fever or Infective Mono nucleosis may give rise to difficulties in diagnosis (p 40)

Acute Axillary Adenitis may complicate infections of the fingers and hand lymphangitis in the forearm boils in the axilla and breast abscesses The infection may be superficial but more frequently is deeply situated in the axilla and if pus ruptures out of a gland it will spread widely beneath the pectoral fascia and may reach the clavicle Incisions should be placed midway between the axillary folds and extend from above downwards the abscess being opened and drained by Hilton s method

Acute Inguinal Adenitis is less common than the foregoing It results from infection in the lower extremity penis scrotum vulva perineum buttocks anal canal and the lower part of the abdominal wall. A vertical incision is not only the safer method but also has the added advantage that when the patient is sitting up it will gape better drainage being thereby assured.

In all these abscesses aspiration of the pus with injection of 4 c c of penicillin solution may be tried before incision.

CHRONIC LYMPHADENITIS

Chronic Simple Lymphadenitis is more common than is generally supposed, for many chronic enlargements of lymph glands are diagnosed clinically as tuberculous while showing no evidence of tuberculosis histologically This condition is commonly seen in the neck following chronic sepsis in the scalp of children, and infections of the tonsils adenoids and teeth in people of all ages. The chronic adenitis may be due to an incomplete resolution of an acute attack, but is often the initial lesion. The affected glands are moderately enlarged, rounded firm but not hard, only slightly tender and painful, and not adherent to each other or to surrounding structures Suppura tion is unlikely to occur and when it does the infection is primarily tuberculous Hard shotty glands in the groin are palpable in all men and many women and are said to be due to slight injuries strains and muscular action whereby lymph vessels are ruptured and small resultant hæmorrhages reach the glands

Treatment entails the removal of the primary cause and attention to the general health. If enlargement persists for three months after the cause has been treated, the glands should be removed

Chronic Syphilitic Lymphadenitis occurs in all stages of the disease

1 The primary sore is accompanied by an enlargement of the glands draining the area and the reaction is usually more severe in extragenital than in genital chancres This is particularly true of chancres of the finger and lip in which large masses of fleshy glands may arise in the axilla or neck

2 The secondary stage is marked by a transient slight enlargement

of all the glands in the body notably those in the posterior triang of the neck and in front of the elbow

3 Gummatous affections of the lymph glands are very rare.

Chronic Tuberculous Lymphadenitis occurs commonly in childr and young adults 90 per cent of all cases being before the age c sixteen years It is associated with poor hygienic conditions (lad of air and sunlight) and inadequate feeding It is probable that the glands are prepared for the planting of the tubercle bacilli by having previously been the seat of a simple lymphadenitis The bacilli gain entrance through the upper and lower air passages the mouth and gastro-intestinal tract and very rarely through the skin the glands affected therefore are the cervical, mediastinal and mesenteric The portal of entry is often a chronic septic focus in the tonsils adenoids or teeth, but the bacilli may penetrate normal mucous membranes The inguinal and axillary glands are not commonly affected, though the latter may be involved in a spread of infection from the neck. The pathological changes in the glands differ in no way from those described as occurring generally in tuberculosis (Chap IV)

The first stage of the disease consists in a soft fleshy enlargement of the gland which may reach several times its usual size but which is otherwise normal in appearance and consistence It is freely movable since the inflammation is as yet confined to the gland parenchyma and there is no periadenitis This stage is characterised microscopically by a proliferation of the lymphoid corpuscles the presence of typical tuberculous giant cell systems and an increase in the fibrous tissue of the gland and of its capsule Early recognition and treatment will succeed in clearing up a number of cases in this stage but the majority will proceed to periadenitis and caseation. Caseation starts as minute yellow points of necrosis in the giant cell systems and these gradually enlarge and finally coalesce so that the gland is converted into a caseous mass inside a thickened fibrous capsule outside which periglandular inflammation spreads into surrounding tissues (Fig 148) The glands become matted together and firmly adherent to other structures *e.g.*, in the neck, the internal jugular vein and sternomastoid muscle. The ultimate fate of a caseated lymph gland may be

1 To remain unaltered for many months
2 To undergo spontaneous cure by a slow process of fluid absorption fibrosis and shrinkage until only a small hard nodule remains Such glands frequently become calcified especially in the mesentery
3 To form a cold abscess by liquefaction of the caseous contents
4 To suppurate owing to a secondary pyogenic infection

Suppuration therefore may be due either to liquefaction or to pyogenic infection In each case pus forms in several foci the spread and coalescence of which lead to the formation of a single cavity Periadenitis becomes more marked than before and several adherent suppurating glands may break down to form a large multilocular cavity If the glands are superficial, the skin will become adherent

and involved in the inflammatory process If adequate treatment is not instituted the skin breaks down and the caseous and purulent contents of the gland are discharged The result is either a typical tuberculous ulcer or a sinus which will not heal readily and even when healing does occur the scar will be puckered keloidal and vascular



Fig. 148
Caseating tuberculous glands.

Treatment —In the early stages before caseation has occurred conservative measures should be adopted The first essential step is the removal of any chronic septic focus which may have been the portal of entry—the teeth tonsils and adenoids being especially scrutinised If possible the patient should be sent to the seaside to live an open-air life and be given good food and a course of calciferol for a period not exceeding six weeks. In the absence of direct sunlight ultra violet ray treatment is beneficial X rays and radium have their advocates, and the former do have a good effect in some cases but they render any subsequent operation more difficult owing to the fibrosis they cause During conservative treatment the progress of the glandular swelling must be carefully watched and the situation reviewed at the end of three months

Operative treatment consists in complete removal if (1) Routine medical treatment has failed to achieve any improvement (2) the disease is spreading to other glands and (3) caseation or suppuration is present. Extensive glandular involvement is to be recognised as an expression of generalised tuberculous infection and treated by full sanatorium regime Operation is often postponed too *long and should always be done before the skin is involved* If this has occurred complete removal may be impracticable and the operator will have to be content with incision and curettage of all tuberculous material

Tuberculous Cervical Glands.—The glands chiefly affected are the upper deep cervical group of which the first is usually the tonsillar gland behind the angle of the jaw The disease is frequently bilateral and the glands become adherent to the internal jugular vein and to the sternomastoid muscle When suppuration occurs a collar-stud abscess may form, the inflammatory process eroding a narrow channel through the cervical fascia and pus collecting in the subcutaneous tissues In operating upon these superficial abscesses the surgeon must carefully seek for the opening enlarge it and remove the deep-seated gland.

In the neck great care must be directed to the incision in order to obtain the least visible scar The cut along the anterior border of the sternomastoid muscle gives splendid access but a poor scar and so is to be avoided Curved incisions following the skin creases below the

jaw and above the clavicle give the best results (Fig 149). Periadenitis may make the operation difficult and particular care must be taken to avoid the inframandibular branch of the facial nerve the spinal accessory vagus hypoglossal and sympathetic nerves The common facial and external jugular veins will usually need to be tied, and if there appears to be serious danger of tearing the internal jugular vein it should be divided between ligatures both above and below the glands and the intervening portion removed *en bloc* These operations should never be undertaken lightly as the glandular involvement invariably proves more extensive than is apparent from the clinical examinati and further the possibility of a collar-stu extension must never be forgotten in eve superficial abscess



Fig 149
Incisions for the removal of tuberculous glands in the neck.

Tuberculous axillary glands may be seen as the result of extensi from the neck the breast a rib or the upper extremity Comple extirpation of the affected glands is the most satisfactory treatment. Tuberculous glands in the mesentery are described elsewhere (Chap XXVI)

Reticulosis

The term reticulosis in its strictest interpretation covers every pathological condition in which cells of the reticulo-endothelial system proliferate in response to some form of stimulus It would therefore be applicable to every form of inflammation

Reticulosis however has come to have a more limited application to certain pathological states in which reticulo-endothelial proliferation is associated with a number of fairly well-defined clinical conditions. Although refinements of microscopical classification have led to many named varieties we are here concerned only with Hodgkin s disease lymphosarcoma reticulo-celled sarcoma giant follicular reticulosis and Boeck s sarcoid.

Lymphadenoma

Hodgkin s Disease is a relatively rare condition which affects the lymph glands and the lymphoid tissue throughout the body It occurs more frequently in men than women and usually first appears in the second or third decade of life though no age is exempt The cause is unknown and considerable doubt exists as to its exact nature—either an obscure neoplasm of lymphoid tissue of the type of a malignant lymphoma or a chronic granulomatous inflammation, possibly due to a virus infection Its histological structure suggests the latter while its clinical behaviour supports the former view The disease begins in one group of glands later spreads to the lymph glands all over the body and attacks the spleen (Fig 150) liver bone marrow and Peyer s patches in the intestine The groups primarily affected are those in

the neck (Fig 151) groins mesentery and mediastinum and the disease may remain apparently localised for many months—or even years—before spreading widely but in some patients the general involvement occurs rapidly and death may follow within eighteen months of the onset In rare instances the testis and the female breast have been involved



FIG 150

Patient showing lymphadenoma of right cervical glands, right breast and spleen. Ascites is present.

The glands themselves become enlarged and on cross-section are homogeneous having lost all differentiation between cortex and medulla (Fig 152) One type presents an increase of fibrous stroma and in this the glands are hard and the disease is slow Another type has little or no fibrosis and the glands are soft and the progress rapid The glands may show small grey or white spots and the spleen often contains well-defined nodules of the same variety (hard bake spleen) The histological picture is characterised by a relative decrease in the number of lymphocytes an increase in endothelial cells a well marked eosinophilia and the presence of small well-defined multinucleated giant cells containing four to eight nuclei (Dorothy Reid cells)

Clinically the group of enlarged glands is very characteristic The swelling is large and soft and even to the naked eye the individual glands appear separate. The glands vary in consistency though they never become hard and always remain discrete and freely movable on each other and on surrounding structures The skin never becomes adherent and suppuration is unknown Sooner or later the glands in the axillæ groins abdomen and chest are involved and the spleen and liver become palpably enlarged. Mediastinal involvement may lead to venous engorgement and cyanosis in the neck dyspnœa and stridor while ascites may follow enlargement of the abdominal glands In the later stages especially of the more acute type recurrent attacks of fever occur with painful swelling of the glands Death follows from cachexia or from mediastinal pressure

Treatment consists in the exhibition of arsenic and of intensive X ray therapy In the early stages while the enlargement is limited to one lymphatic field a radical removal of all glands in that area is considered justifiable Such operative intervention is said to make X ray treatment more efficacious and so improve the prognosis As time goes on, treatment becomes less and less useful and fails to prevent a fatal issue nevertheless X rays should be pushed to the ultimate limit of tolerance as remarkable improvements do sometimes occur and many years of useful life may be preserved

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FIG. 149
Incisions for the removal of tuberculous glands in the neck.

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Fig. 151
A large mass of lymphadenomatous glands.



Fig. 152
Lymphadenomatous glands from the neck.



Fig. 153
Mediastinal lymphosarcoma surrounding and compressing the heart.



Fig. 154
Secondary carcinomatous glands in the neck with superadded pyogenic infection forming large abscess.

LYMPHOSARCOMA

This is a type of round-celled sarcoma arising in lymphoid tissue having certain histological and clinical characters which warrant its description as a separate entity (Fig 153) It occurs in either sex and at any age but especially in younger people and is most frequently seen in the ileocæcal region (arising probably in a Peyer's patch) the mediastinum (in the remains of the thymus) the tonsil and the cervical gland It begins in one gland or area of lymphoid tissue rapidly spread by the lymph vessels to neighbouring lymph glands and bursting through the gland capsule infiltrates the surrounding tissues The ileocæcal growth spreads in the submucous coat and forms a large mass with the adherent lymph glands In the mediastinum lymphosarcoma grows rapidly to great size invading the lung and heart and spreading to the abdominal gland

Lymphosarcoma forms a large rounded hard tumour with an irregular surface and on cross-section presents a whitish homogeneous appearance speckled with areas of hæmorrhage and necrosis Microscopically it bears a close resemblance to the small round-celled sarcoma, the proliferating cell being the small lymphocyte but it possesses a much more abundant framework of delicate intercellular fibril Clinically the symptoms depend on the site of the growth being produced by pressure on surrounding structures Ulceration will occur if the growth is superficial (*e g* in the tonsils and cervical glands) and a fungating mass will result The progress of the disease is usually very rapid, and towards the end generalised blood stream metastases occur Death results from toxæmia cachexia or cardiac and respiratory failure

RETICULO-CELLED SARCOMA

In this disease there are certain minor differences which distinguish it from the foregoing It affects men more than women and is not so frequently seen in young people The distribution is similar to that in lymphosarcoma but it starts more commonly in the lymph glands of the neck and axilla and it appears to have an affinity for the testis Its general macroscopic appearance is indistinguishable from that in lymphosarcoma but microscopically the dominant cell resembles the large lymphocyte

GIANT FOLLICULAR RETICULOSIS

There is a small number of cases clinically identical with lymphosarcoma which have such well-defined pathological characteristics that they are classified separately The proliferation is chiefly confined to the follicles of the reticulo-endothelial system and as a result these stand out prominently if lymph glands or the spleen be cut across

The *prognosis* in these three conditions is almost inevitably hopeless Regressions may occur but eventually death closes the scene

Treatment —In the early stages when the disease appears clinically to be localised to one group of lymph glands complete removal should



FIG. 151
A large mass of lymphadenomatous glands.



FIG. 15_
Lymphadenomatous glands from the neck.



FIG. 153
Mediastinal lymphosarcoma surrounding and compressing the heart.



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Secondary carcinomatous glands in the neck with superadded pyogenic infection forming a large abscess.

LYMPHOSARCOMA

This is a type of round-celled sarcoma arising in lymphoid tissue having certain histological and clinical characters which warrant its description as a separate entity (Fig 153) It occurs in either sex and at any age but especially in younger people and is most frequently seen in the ileocæcal region (arising probably in a Peyer's patch) the mediastinum (in the remains of the thymus) the tonsil and the cervical glands It begins in one gland or area of lymphoid tissue rapidly spreads by the lymph vessels to neighbouring lymph glands and bursting through the gland capsule infiltrates the surrounding tissues The ileocæcal growth spreads in the submucous coat and forms a large mass with the adherent lymph glands In the mediastinum lymphosarcoma grows rapidly to great size invading the lungs and heart and spreading to the abdominal glands.

Lymphosarcoma forms a large rounded hard tumour with an irregular surface and on cross-section presents a whitish homogeneous appearance speckled with areas of hæmorrhage and necrosis Microscopically it bears a close resemblance to the small round-celled sarcoma the proliferating cell being the small lymphocyte but it possesses a much more abundant framework of delicate intercellular fibrils. Clinically the symptoms depend on the site of the growth being produced by pressure on surrounding structures Ulceration will occur if the growth is superficial (e.g in the tonsils and cervical glands) and a fungating mass will result The progress of the disease is usually very rapid, and towards the end generalised blood stream metastases occur Death results from toxæmia cachexia or cardiac and respiratory failure

RETICULO-CELLED SARCOMA

In this disease there are certain minor differences which distinguish it from the foregoing It affects men more than women and is not so frequently seen in young people The distribution is similar to that in lymphosarcoma but it starts more commonly in the lymph glands of the neck and axilla and it appears to have an affinity for the testis Its general macroscopic appearance is indistinguishable from that in lymphosarcoma but microscopically the dominant cell resembles the large lymphocyte

GIANT FOLLICULAR RETICULOSIS

There is a small number of cases clinically identical with lymphosarcoma which have such well-defined pathological characteristics that they are classified separately The proliferation is chiefly confined to the follicles of the reticulo-endothelial system and as a result these stand out prominently if lymph glands or the spleen be cut across

The *prognosis* in these three conditions is almost inevitably hopeless. Regressions may occur but eventually death closes the scene

Treatment —In the early stages, when the disease appears clinically to be localised to one group of lymph glands complete removal should

be advised Intensive X ray treatment will follow I have lost an old friend who had had a mass of glands in the neck removed three years and two months before death During this time he developed an enlarged testis which was removed, and it was only six weeks before the end that he abandoned his work as a waiter in the Great Western Royal Hotel.

Recently a new method has been on trial which is being applied to all the reticuloses Although by no means devoid of danger the administration of nitrogen mustard hydrochloride (2-chloro-ethyl methylamine hydrochloride) has had most striking immediate results. It is given intravenously in doses of 0 1 mg per kilo of body weight once daily for four days. The glandular swellings subside rapidly but the eventual prognosis does not seem to be improved

Boeck s Sarcoid

The problem of the exact pathological status of this condition defies decision It is placed amongst the reticuloses though many pathologists and clinicians believe it to be an atypical manifestation of tuberculosis. The reticulo-endothelial system, the lungs and the heads of the phalanges of the fingers may all be affected. At the present time there can be no doubt that the diagnosis of Boeck s sarcoid is made too readily and too often in patients who present a puzzling clinical picture

Carcinomatous involvement of the lymphatic glands is common to every type of carcinoma in all parts of the body The cells invading the lymph glands are similar in all respects to those of the primary growth, from which they have come The gland tissue is replaced by tumour cells which soon spread outside the gland capsule and invade glands in the same group and other neighbouring structures. Necrosis or superadded pyogenic infection will lead to the formation of an extensive abscess the drainage of which results in a fungating and ulcerating growth on the surface Fig 154 shows such an abscess in the neck

R M Handfield-Jones.

CHAPTER XVII

THE FACE, LIPS AND JAWS

THE FACE

DEVELOPMENT.—Some simple explanation of facial development is necessary for a thorough understanding of the formation of hare-lip cleft palate and other abnormalities. At about the fifth week of fœtal life the primitive cerebral vesicle extends forward to bend over the anterior end of the notochord. This medial prolongation is known as the frontonasal process. At the same time the stomodeum (primitive buccal cavity) is encroached on laterally by two pairs of processes, the maxillary above and the mandibular below thus giving it the typical quinqui radiate appearance. The mandibular processes develop more rapidly and unite across the midline about the sixth week to form the lower jaw. The formation of the upper jaw is more complex and takes longer not being completed until a month after this. The frontonasal process develops on each side of a median groove, an internal and external nasal process. Between these two occurs a pouch which ultimately becomes the anterior nares and between the external nasal and the maxillary process runs the naso-orbital fissure in which appears the primitive ocular vesicle. The upper lip is formed by the fused internal nasal (or globular) and maxillary process on either side together uniting across the midline. It will be noted therefore that the external nasal process does not take part in the formation of the free margin of the upper lip but by its junction above this level with the united globular and maxillary processes leads to an infolding of the naso-orbital fissure which remains in adult life as the nasal duct running from orbital to nasal cavities. The external nasal process itself forms the external part of the anterior nares. At the same time as these external changes are taking place both the internal nasal and the maxillary processes are sending in deeper subsidiary processes, the former resulting in the rudimentary premaxilla and the latter the hard palate behind and the incisor processes in front. The incisor processes meet in the midline to complete the upper jaw and bear the incisor teeth at the same time excluding the premaxilla from the alveolar margin, these small bones occupying a triangular area immediately posterior to the junction of incisor processes and anterior to the united palatal processes forming the hard palate. The limit of this triangular area is marked in the adult palate by the position of the anterior palatine canal. The reader is referred to Figs 169 and 170 on p 330

CONGENITAL DEFORMITIES

Hare-lip is a congenital cleft in the upper lip due to failure of fusion between the internal nasal process and superficially the maxillary and deeply the external nasal processes. The term itself is a misnomer

as the hare's lip is a Y-shaped cleft median at the lip margin and dividing above to reach each nostril Hare-lip may be either *simple* or *complicated* (*alveolar*) either the superficial soft parts alone being involved or the alveolus also split in which latter case the fissure extends back into a cleft palate Hare-lip is further classified as *complete* or *incomplete*. In the former the cleft reaches into the corresponding nostril. Again it may be *unilateral* or *bilateral* or very rarely truly *median* The unilateral and complete cases are much commoner than the bilateral and incomplete The frequency of occurrence is approximately unilateral complete 50 per cent unilateral incomplete 35 per cent bilateral complete 10 per cent bilateral incomplete 5 per cent In the unilateral cases the left side is involved twice as often as the right The bilateral cases are usually alveolar in type and the failure of development in the incisor outgrowths from the maxillary processes allows the premaxilla to present anteriorly This protruding portion of bone and skin is often called the os incisivum, and in most cases carries the central incisor deciduous teeth, the lateral incisors being on the medial limits of the imperfectly developed maxillary processes



Fig. 155
A baby with complete unilateral hare-lip and cleft palate.

A flattened nose with splayed out nostrils is typical of all cases of hare-lip and the deformity is often associated with other evidence of maldevelopment *e.g* spina bifida talipes syndactyly etc The minor degrees of hare-lip are important only in so far as they are disfiguring The more severe forms especially if combined with cleft palate lead to difficulty in suckling and later in speech (Fig 155)

Treatment is by operation and this should be carried out as soon as the baby's general condition and state of nutrition permit. Weight is a valuable guide but should not be the sole indication as to time for operation. The more the alveolar (and palatal) involvement associated with the hare-lip the earlier should operation on the latter be undertaken, as the closure of the lip is of considerable value in effecting a partial natural narrowing of the bony defect behind. In general the operation for hare-lip should be carried out somewhere between the sixth and twelfth week of life

Many methods are used varying with the type and degree of deformity and the preference of the surgeon. The essential points in all may be briefly summarised The split lip is dissected up from the maxilla on its under surface through an incision at the reflection of the mucous membrane from lip to gum This is particularly necessary on the outer side of the cleft and the more the flattening of the

corresponding nostril the higher should this dissection be carried The edges of the cleft are pared and if necessary a small piece of skin removed from the floor of the flattened nostril The two raw sides of the cleft are then united either directly (Rose s method) (Fig 156) or by means of suitably fashioned flaps (Mirault s method) (Fig 157) Two or three tension sutures from mucosa on one side through and back through mucosa on the other side are inserted Buried sutures are best avoided The red margins of the lip are then carefully approximated, and finally skin and mucous membrane sewn up with interrupted sutures of very fine silkworm gut A simple collodion or mastisol dressing or Whitehead s varnish may be used Logan s tension bow is of great service in preventing any pull on the suture line After treatment should include application of padded splints to the baby s arms to prevent interference with the operation site

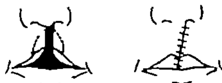


Fig 156

Diagram illustrating Rose operation for unilateral hare-lip



Fig. 157

Diagram illustrating Mirault's operation for unilateral hare-lip.

and most careful feeding with a spoon or preferably a nasal tube Sutures should be removed about the fourth day but the tension bow retained for a week

In bilateral cases the treatment of the soft parts is on similar lines but the presence of the os incisivum requires further attention The skin over this, pared down to a wedge shape can usually be used in remodelling the lip It is the treated cases of bilateral hare-lip which so often present that most disfiguring tight, flattened upper lip with inverted red margin For such cases Gillies cupid s bow operation offers great improvement but should not be attempted before the age of ten

Macrostoma and Microstoma.—These terms are applied to the conditions resulting from either lack of normal or excessive fusion of the maxillary and mandibular processes in the formation of the cheek, resulting in either an abnormally wide or small oral aperture. Macrostoma is frequently associated with the presence of accessory auricles, microstoma with faulty development of the alveolar processes

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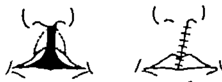


FIG 156

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especially of the mandible Macrostoma is treated by paring the outer portions of the cleft and suturing mucosa and skin microstoma by slitting the small orifice laterally and uniting skin to mucosa.

Facial Clefts, etc.—(*a*) A FACIAL CLEFT is due to persistence of the naso-orbital fissure and therefore replaces the nasal duct as a groove running from the outer side of the nostril to the inner canthus of the eye It is a rare deformity and may be incomplete involving skin only or complete when bone is also affected

(*b*) A MANDIBULAR CLEFT is even more uncommon and is the result of non fusion of the mandibular processes in the midline In its simple form with soft tissues only affected, it therefore produces a median lower hare-lip In its complicated form there may be actual absence of bone and even an accompanying bifid tongue

INFECTIONS

Certain skin infections *e.g* boils and carbuncles, erysipelas, lupus impetigo syphilis and acne, have special significance when occurring on the face These subjects will be found fully discussed in Chaps. III, V and XIII

GROWTHS AND CYSTS

The following growths may be found on the face benign—papilloma, hæmangioma lymphangioma and melanoma malignant —melanoma, rodent ulcer and squamous-celled carcinoma. Of the cysts sebaceous and dermoid are those of most frequent occurrence

Papilloma may occur anywhere on the face and has the usual warty characteristics Irritation from for example, shaving may lead to a malignant metamorphosis and if there is any chance of this happening excision should be advised

Hæmangioma.—Both capillary and cavernous nævi are frequently found on the face and vary in size from a pin s head to a com plete involvement of one side The smaller variety are frequently multiple The lay names of birth-mark and port wine stain" are particularly applied to facial nævi In the smaller types ex cision should be carried out where possible if increase in size is noted or disfigurement is considerable Otherwise for the capillary variety carbon-dioxide snow application is usually satisfactory whilst the cavernous type which if anything favour the eyebrow and eyelid regions may be treated with electrolysis cauterisation or the injection of some sclerosing solution

Massive and extensive hæmangiomata can be adequately treated only by excision and carefully planned skin grafting

Lymphangiomata are not very common, occur usually in an area just anterior to the external auditory meatus and are of the cavernous and cystic type They are not large as a rule and should if possible be dissected out

Melanomata. The pigmented mole is of frequent occurrence on the face The pigment melanin is found in the deeper layers of the

cutis vera and is partly intracellular and partly extracellular It is typical of these growths that portions of them are completely un pigmented Benign forms exist quite happily throughout life on the face and are in fact often cherished possessions (beauty spots) But of their potential malignancy there is no doubt (Fig 138) and very small irritative factors often in fact unnoticed are responsible for a change in their character Once this has occurred they rank amongst the most malignant tumours yet known There is usually but little increase in size of the primary growth although areas of thicken ing or changes in degree of pig mentation may be noted But lymphatic spread is exceedingly rapid and widespread, practically every organ in the body being *affected. The secondary growths are frequently unpigmented*



FIG 138

A malignant melanoma of the cheek.

Hence although wholesale removal of all facial moles is not advocated it cannot be overstressed that any changes occurring in a simple melanoma or any risk of constant irritation should demand immediate and radical excision



FIG. 139

An unusually large slowly growing warty carcinoma of the face

Rodent Ulcer—The face is the most common site of the rodent ulcer and the area it *chiefly attacks is a triangular* one roughly bounded on each side by the outer end of the eyebrow and by the alæ nasi probably 90 per cent of rodent ulcers occurring within this area Its features are described in detail elsewhere (p 237) Where size and extent of deeper involvement make it possible there is no doubt that excision is the best treatment Failing this the use of radium (either by interstitial needles or superficial application of plaques) is preferable to deep X ray therapy and carbon dioxide snow and caustics should not be used

Squamous-celled Carcinoma is of relatively frequent occurrence on the face Starting either in a wart or less commonly in a persistent crack or fissured ulcer it slowly

develops into the characteristic malignant ulcer Rarely it forms a huge warty mass (Fig 159) Glandular spread is late Treatment should be by excision where possible and failing this by radium and X-ray therapy

Sebaceous Cysts are frequently found on the face Their large central pore fixity to skin, globular shape painlessness and soft pultaceous feel make them easy to diagnose Practically all the complications that may accompany sebaceous cysts (inflammation, suppuration, calcification, pedunculation rupture and the formation of horns adenomata and carcinomata) are also well exemplified in the face The only satisfactory treatment is removal with subsequent careful suturing A certain proportion can be successfully removed from the buccal aspect of the cheek, hence avoiding an external scar Inflamed or suppurating cysts should be incised and curetted but not excised.



FIG 160

Macrocheilia from a congenital hæmangioma. A similar condition is seen in the tongue as a result of a congenital lymphangioma.

Dermoid Cysts are again of relatively frequent occurrence and can occur in any of the developmental junction lines of the face e.g., in the midline at the nasion or in the middle of the chin at the outer canthus of the eye, in the line of the nasal duct from inner canthus to external nares or in the line from external auditory meatus to angle of mouth Typically deep to the skin fixed to deeper structures often to bone relatively mobile soft and painless they are usually easily diagnosed.

If they occur in or persist until adolescence they should be carefully dissected out

THE LIPS

CONGENITAL DEFECTS

Macrocheilia, or hypertrophy of the lip is of two types congenital and acquired The congenital variety is either a lymphangiectasis or a cavernous hæmangioma and the typical swollen, firm thick everted lip is further characterised by numerous small lymph vesicles It is more commonly seen in the lower lip and is treated, if the degree of disfigurement merits it by a wedge-shaped resection of a complete portion of the lip (Fig 160)

The acquired variety is due to inflammatory causes and may be acute or chronic The former occurs when acute septic conditions

of the skin of or near the lip are present e.g boils and subsides to normal once the causal lesion has been adequately treated Not so the chronic variety which is persistent and progressive and may be due to the fibrosis of either tuberculous or syphilitic infections The tuberculous type is usually seen in children or young adults affects chiefly the upper lip and is due to a chronic lymphangitis The lip is swollen with a firm brawny oedema and often presents multiple fissures and cracks It is to this type that the term strumous lip is applied Syphilitic macrocheilia occurs in the tertiary stage of the disease and is typically confined to the lower lip The hypertrophy is due to a diffuse fibrosis Treatment of both these latter varieties is that of the causal disease

ULCERS

Ulcers of the lips may be simple herpetic syphilitic tuberculous or malignant

(a) **Simple Ulcers** (cracked or chapped lips) are usually due to exposure particularly in those who are suffering from a cold " Such patients frequently have other evidences of poor circulation e.g chilblains The ulcers mainly on the lower lip take the form of superficial and very painful fissures which are kept open by the continual movements of the lips in talking and eating They tend to heal spontaneously and are best treated by a simple emollient such as zinc ointment or lanoline Stubborn and very painful fissures should be touched with the silver nitrate stick

(b) **Herpetic Ulcers** occur on both lips but as a rule are unilateral A series of submucous vesicles appear usually in a patient with some catarrhal condition of the respiratory tract and these are surrounded by small painful inflamed areas The vesicles soon become purulent burst dry up and heal rapidly within a week or ten days from their onset The surface application of absolute alcohol surgical spirit or some astringent lotion may relieve pain and hasten resolution

(c) **Syphilitic Ulcers** are of four types—congenital (really tertiary in character) primary secondary and tertiary The congenital ulcers take the form of deep fissures and cracks occurring particularly at the angles of the mouth. Secondary infection leads to further extension, and when healing ultimately takes place radiating scars extending out into the cheek (*rhagades*) provide a very characteristic feature in the congenital syphilitic facies

The primary ulcer (chancre) is acquired by contact infection with a secondary syphilitic or some object (e.g glasses cups pipe etc) used by him. It is rather more frequently seen on the upper lip is a flat ulcer without the typical induration of the genital chancre tends to involve neighbouring skin more than mucosa, and is accompanied by a more intense infiltration of surrounding tissues and a more marked glandular (submaxillary) enlargement than is seen elsewhere (Fig 15 on p 64)

The secondary ulcers on the other hand affect mucous membrane almost entirely and are therefore more in evidence on the

inner aspects of the lips particularly near the angles of the mouth. The typical shallow elongated snail track ulcers are seen with their surrounding mucous tubercles They are surprisingly painful.

The tertiary ulcer is essentially a broken-down gumma and has the characteristic serpiginous edge punched-out deep crater and sloughing floor Gland involvement is minimal.

The treatment of all types is that of the general disease

(d) **Tuberculous Ulcers** are of two types—the fissures already described which, by their secondary infection, lead to the strumous lip of children and the lupus ulcer a progressively spreading and destructive superficial ulcer preceded by a crop of pale tubercles General treatment is again indicated

(e) **Malignant Ulcers** form one variety of squamous-celled carcinoma of the lip The thickened rolled everted edge indurated base and unhealthy ragged floor are characteristic They are more commonly found in the lower lip

Rodent ulcers may occur chiefly on the upper lip

GROWTHS AND CYSTS

Benign growths of the lip include papilloma and hæmangioma malignant growths rodent ulcers and carcinoma The mucous retention cyst is that most commonly found.

(a) **Papillomata** favour the lower lip particularly the neighbourhood of the angle of the mouth. Seeding from one lip to another is frequently seen They appear as the usual warty cauliflower excrescence and the absence of basal induration, superficial ulceration and glandular involvement differentiates them from the papilliferous type of carcinoma In view of the fact that they grow and multiply and that ultimately some assume malignant characteristics they should be excised locally

(b) **Hæmangiomata** are seen in both their capillary and cavernous forms and show no particular preference for one lip If small they should be excised completely otherwise they are best treated by diathermy electrolysis or the injection either of boiling water or some sclerosing fluid

(c) **Rodent Ulcer** is not common on the lips and when found is usually on the upper Starting as a hard nodule it gradually breaks down to form the chronic non healing ulcer which resembles carcinoma except that it lacks the characteristic peripheral induration and accompanying glandular involvement Such ulcers react well to radium applied either by interstitial needles or by a surface plaque but if they are not too advanced excision is still the treatment of choice

(d) **Squamous-celled Carcinoma** of the lip is of relatively common occurrence It is practically limited to males 93 per cent of cases occurring in men These patients are usually elderly and it is said that many of them have a syphilitic taint The close relation of

continual trauma—e.g. the clay pipe smoker—to the *incidence* of this growth is well proved. It occurs more frequently on the lower lip and near the corner of the mouth (Fig. 161).

The growth is a typical squamous-celled carcinoma with well marked "cell nests." It may be morphologically either papilliferous, ulcerative or *infiltrative*. The papilliferous type may start as an apparently simple wart or may assume malignant characteristics—induration, ulceration and secondary *glandular involvement*—from the first. This type soon fungates and so becomes secondarily infected. The ulcerative variety starts with *induration in an* already existing fissure. The infiltrative type shows no superficial ulceration but a generalised thickening and hardening of a part of the substance of the lip. It is not *common*.



FIG. 161

A squamous-celled carcinoma of the lip at the angle of the mouth.

All malignant growths of the lip *are characterised by their relatively* slow rate of advancement. Glandular involvement is late, after about a year, and not marked until the primary growth is very advanced. The glands affected are the submaxillary and submental with extension to the upper deep cervical in the later stages. Secondary infection leads to matting *of the groups of glands* and ultimately in the worst cases these break down, fungate on the surface and may lead to the patient's death from exhaustion due to pain and toxæmia secondary to widespread sepsis or hæmorrhage. Generalised metastases are exceptional.

Treatment.—Any indurated area in the lip, be it warty or ulcerated, should be regarded with suspicion and a biopsy performed.

If operable, *the primary growth should be treated by excision*, a wide wedge of the lip being removed.

These growths react well to radium applied either by interstitial needles, surface plaques or teletherapy with a bomb, but when excision is possible it is preferable.

Secondary glands should always be dealt with whether clinically affected or not. This is preferably done at the same time as the excision of the primary growth. Radium (preferably bomb therapy) can be used in the inoperable cases, although as a rule alleviation of pain and temporary regression are all that can be expected.

(c) **Mucous Cysts** of the lips occur on the inner aspect, more commonly of the lower lip. They are retention cysts of the small mucous glands and are due to fibrosis of the opening of the duct

probably the result of trauma e.g biting the lips They present as small tense smooth swellings *globular in shape* and typically painless. They contain a thick glairy mucoid fluid.

Treatment is excision.

THE JAWS

FRACTURES

The Maxilla is usually fractured by direct violence and this is often accompanied by damage to nasal malar and lachrymal bones. The majority of these *fractures are compound as even in the absence* of overlying skin injury they open into various cavities of the mouth, nose and accessory air sinuses Thus there is always considerable *risk of sepsis with secondary* bone necrosis. In the absence of this complication *union is rapid and treatment is conservative and* symptomatic If depressions in the neighbourhood of the zygoma are likely to be disfiguring they should be elevated either by the use of a blunt hook through a small incision or in complicated cases by open operation

The Mandible is again usually fractured by direct violence but indirect violence, *i.e.* a *force applied to one part or side of the lower jaw producing a fracture in another part of the opposite side*, accounts for a definite percentage Pathological fractures due to underlying bone disease are relatively common

The mandible can be fractured at the following sites —

(*a*) Body —*This is usually due to direct* violence, and occurs through the weakest part of the bone at the level of the canine fossa, just anterior to the mental foramen. Unless bilateral, when the separate middle fragment is drawn markedly downwards and *backwards displacement is not usually* very great The outer fragment tends to be pulled upwards and slightly backwards. Owing to the firm attachment of the buccal mucous membrane to the *alveolar* periosteum practically all *these fractures are compound.*

(*b*) Angle —In this another direct-violence fracture the line of cleavage passes up obliquely from the junction of body and ascending ramus to the *alveolar margin* either in front of or behind, the last molar tooth If complete they are again usually compound Displacement is minimal

(*c*) Ascending Ramus —*Usually* the result of direct violence, not compound and, *owing to the mass* of muscle on both internal and external aspects shows practically no displacement

(*d*) Neck of Condyle.—More usually is due to indirect violence, not compound although the *temporo mandibular* joint may be involved, and shows a typical deformity The small upper fragment is drawn forwards and slightly inwards by the action of the external pterygoid muscle the remainder of the jaw being displaced to the side of the injury

(e) CORONOID PROCESS.—Fractured either by direct violence or muscular traction is pulled upwards by the temporal muscle

Diagnosis of mandibular fractures is usually simple The history of injury with subsequent pain swelling discoloration and loss of function (opening and closing the mouth) make a characteristic picture. Crepitus is easily elicited in the common fracture of the body and irregularity in the line of the teeth with displacement of the fragments of the jaw clinches the diagnosis The pain at first is considerable and is probably due mainly to tension of the traumatic effusion beneath the closely attached alveolar mucosa rather than to involvement of the inferior dental nerve and its branches

Treatment should be instituted as early as possible and should in no way deviate from that of fractures elsewhere i.e it should consist in reduction adequate immobilisation and maintenance of function of surrounding parts But it cannot be too emphatically stressed that the advice and co-operation of a dental surgeon should be enlisted from the first in any except the simplest cases

As a general rule loose teeth and those involved in the fracture line should be removed Their presence is always an open invitation to sepsis The one exception to this is in the case of the last molar which may afford the only means of fixing the posterior fragment in fractures extending up to the alveolus from the angle

Reduction if necessary should be carried out under full anaesthesia Immobilisation may be obtained by the following methods —

(a) **Bandages.**—The four tail " bandage which slings up the point of the chin the ends being tied two over the vertex and two just above the external occipital protuberance is still the commonest method and all that is needed in simple fractures without much displacement It has the great disadvantage of dragging the anterior fragment backwards i e increasing the deformity The Barrel bandage which goes under the chin well back and is attached above to a circular band round the forehead and occiput is definitely preferable the pull here being upwards and forwards

(b) **Splints.**—Specially fitted splints of celluloid leather rubber or even light plaster of Paris can be moulded to the external aspect of the mandible and attached by cords rubber bands or bandages to the vertex

(c) **Dental Splints.**—These can be made either of dental wire vulcanite or malleable metal They are fitted over all the lower teeth holding them firmly together and may if necessary be fixed by bars between the lips to some external form of splintage They are used in cases where displacement is not too great and where reduction can be easily maintained

(d) **Interdental Splints,** especially in any bad fracture are preferable to the above They are made either from malleable metal or wire

the lower jaw ultimately heals much better than the upper with the formation of strong new bone The upper jaw seldom regenerates beyond the stage of firm fibrous tissue

The first signs of jaw infection are usually vague pain in the teeth and a disinclination to close the jaws tight Pain soon becomes more intense and is accompanied by marked swelling of the jaws face and neck The temperature rises rapidly often with rigors and the pulse rate follows it There is inability to open the mouth either because of the degree of swelling or from reflex spasm Rapidly abscesses form and discharge through multiple sinuses either into the mouth or to the exterior The breath is typically most offensive the teeth become loose and excessive salivation is a constant source of worry to the unfortunate victim The acute stage—if not sufficiently severe to kill the patient as it occasionally is—passes off leaving the many discharging sinuses and behind them sequestra are slowly formed From these factories of sepsis poison is also absorbed to the blood stream and hence toxæmia chronic dyspepsia septic pneumonia and amyloid disease are all frequently seen

Treatment in the early stages consists in suitable chemotherapy and mouth washes Later incision, sequestrectomy when indicated by X-rays and irrigation of resultant cavities with mild antiseptics form the usual line of treatment together with attempts to sustain and build up the patient s general health and resistance

Osteomyelitis.—(*a*) The general blood-stream infection is usually due to spread from a staphylococcal focus elsewhere is typically very acute and often involves completely one or both sides of the mandible A most interesting form of the condition is seen in new born infants It has even been reported as occurring *in utero*

(*b*) Local infection is most commonly derived from dental sepsis resulting in the formation of an alveolar abscess (p 330) Infection may also be introduced locally following dental extractions either from the use of (bacteriologically) dirty instruments or from surrounding sepsis in mouth and gums One of the worst offenders in this latter respect is the impacted or unerupted third molar (wisdom tooth) whose socket is often infected even previous to extraction. Such advanced septic conditions of the mouth as cancrum oris (*q v* p 178) can easily spread to the jaws and produce a necrosis of bone

Compound Fractures always result in some degree of bone necrosis in uncomplicated types only molecular but in comminuted cases or in the presence of gross dental or buccal sepsis it is likely to be extensive

Post-exanthematous.—Necrosis of the jaw usually the mandible is one of the less common sequelæ of the specific fevers, but cases have been reported following measles chicken pox, smallpox scarlet fever and typhoid. The condition is a secondary osteomyelitis predisposed to by the patient s lowered general resistance

lipomata odontomata fibromata and osteoclastomata whilst malignant growths include sarcomata carcinomata and Ewing's tumour

Benign.—OSTEOMATA.—Both the "ivory" and cancellous forms are found Some pathologists include the hyperostoses of leontiasis ossea amongst the latter although these occur in their more characteristic form usually in the neighbourhood of the symphysis menti The ivory type of osteoma either grows from the maxilla into the antrum of Highmore or from the neck or condyle of the mandible. Any of these growths, in particular the last group may give pressure symptoms on major nerves or produce obvious deformity

Treatment is surgical removal

CHONDROMATA are rare occurring chiefly in the mandible either at the symphysis or the region of the condyle If giving symptoms or if disfiguring they should be removed

LIPOMATA are also uncommon They occur subperiostially in relation to the alveolar margin of the mandible, and are frequently not correctly diagnosed until after removal.

ODONTOMATA are tumours derived *essentially* either from the primary or secondary tooth germs They are fully described on p 332

FIBROMATA form one type of "epulis, and are further discussed on p 330

OSTEOCLASTOMATA —These tumours were formerly classed as "myelomata" Two types of osteoclastoma are found, almost exclusively in the mandible one occurring in the gums the other in the jaw bone proper Further consideration of clinical signs, pathology and treatment will be found on p 1098

Malignant.—SARCOMATA occur chiefly in the upper jaw and may originate in the maxillary antrum the nasopharynx or the sphenomaxillary fossa They are more commonly found in younger people and even in children. The pathological types vary—spindle-celled and round-celled predominating A very undifferentiated growth corresponding to Ewing's tumour has been reported. The so-called "recurrent epulis" is usually a fibrosarcoma and favours the mandible Secondary sarcomata are rare

CARCINOMATA again more frequently attack the maxilla than the mandible In the case of the latter, the growth is usually an extension from the tongue floor of mouth, lips or gums A certain proportion of maxillary carcinomata appear to start in the ethmoidal air cells, but the majority originate in or near the maxillary antrum Various cellular types may be found the commonest being cubical-celled, the growth being an adenocarcinoma Occasionally these cells undergo metaplasia with the result that a squamous-celled carcinoma is found More rarely proliferative papilliferous types occur and even primary basal-celled carcinomata ("rodent ulcers") have been described. Despite their marked local effect these growths metastasise comparatively late in the disease and then usually to the submaxillary lymphatic group first

Secondary carcinomatous deposits are infrequently found in the jaws, but primary growths of breast prostate kidney and thyroid sometimes metastasise to these bones—usually the mandible

The Clinical Picture and Treatment of all types of malignant neoplasm of the jaws may be considered together—as exact diagnosis in primary growths is usually only possible pathologically In the upper jaw growths there is typically a preliminary clinical stage when the actual growth itself is not obvious but produces facial pain either of a neuralgic type from involvement of branches of the Vth cranial nerve or boring in character and worse at night from internal expansion of bone With this pain there may be a purulent discharge from the nose occasional epistaxis or polypi presenting at the anterior nares One of the first complaints may be loose teeth Later an obvious bulging of the cheek can be observed and as the growth spreads exophthalmos appears from pressure on the floor of the orbit downward bulging of the hard palate may be visible and obstruction of the nasal duct leads to epiphora The affected side of the face will be dull on oral transillumination and an X ray examination may show an opacity in the antrum or a characteristic shadow in the facial bones All the signs and symptoms are more exaggerated when the growth originates in the maxillary antrum than when it spreads into the antrum from neighbouring regions. Ultimately fungation and ulceration occur with the accompanying possibility of massive hæmorrhage and the growth appears on the surface either through the skin of the cheek or the mucosa of mouth or nasopharynx. It is usually only in this final stage that glandular involvement becomes obvious

In the lower jaw malignant growths are clinically of two types—intra-osseous (the sarcomata and secondary growths) and superficial ulcerative (the carcinomata spreading from surrounding soft parts) In the latter the characteristic malignant ulcer with its rolled, everted indurated edge and irregular bleeding unhealthy floor is easily recognised Starting in the alveolar periosteum it soon invades and destroys the underlying bone leading to a foul sanious purulent discharge in which spicules of bone are frequently found Until the later stages pain is not marked

In contradistinction to this the intra-osseous type gives the boring pain of pathological bone expansion and as in the upper jaw looseness of the teeth may be complained of Ultimately an obvious swelling occurs with breakdown of the growth either to the exterior or to the mouth

Treatment of malignant growths of the jaw consists in excision when possible followed by radium or X ray therapy and for inoperable cases in these latter methods alone together with the administration of suitable drugs to alleviate pain.

Complete excision of the upper jaw is to-day very rarely deemed necessary A growth which demands such radical treatment is essentially inoperable and should be dealt with by radiotherapy In operable cases Moure s method (lateral rhinotomy) or some modification or extension of it is the one usually adopted. This involves an incision from the inner end of the eyebrow on the affected side passing down alongside the nose turning round the ala and going through the midline of the upper lip This flap is turned back

and the soft tissues separated from the underlying bones which are then removed to the extent required either to eradicate the growth or fully expose it in the antrum. It is obvious that for growths involving the floor of the antrum or palate this method is not applicable It has the great advantage of leaving little residual deformity



Fig 104

Result following excision of ramus of mandible with subsequent grafting.

Complete excision of one half of the mandible causes considerably more residual deformity and whenever possible the ascending ramus is preserved. This allows subsequent bone grafting which gives surprisingly good functional and cosmetic results (Fig 104)

In both these operations hæmorrhage is unexpectedly slight Suturing should be done by interrupted stitches particular care being taken to obtain accurate approximation of the red margin of the lips Drainage is always necessary as is pre-operative attention to mouth sepsis and the use of intratracheal anæsthetic to allow the pharynx to be plugged during operation.

Maxillary Antrum.—Apart from the involvement of the maxillary sinus in growths of the upper jaw as described above a more detailed consideration of diseases affecting this cavity will be found in Chap XXI

TEMPORO-MANDIBULAR JOINT

DERANGEMENTS

Dislocation.—The temporo-mandibular joint is a diarthrosis having two complete synovial cavities separated by a fibrocartilaginous disc Dislocation of this joint is not common and when it occurs is practically always forward The very rare backward and upward dislocations the former accompanied by fracture of the tympanic plate and the latter by fracture of the middle cranial fossa require no further description. In the typical forward dislocation the mandibular condyle rides forward over the eminentia articularis to lie in the zygomatic fossa and the intra-articular cartilage owing to the attachment to it of the external pterygoid muscle is also carried anteriorly Dislocation may be unilateral or bilateral and is caused either by trauma (*e.g* blows on the chin with the mouth open excessive pressure from dental gags, or during operations inside the mouth) or by the exaggeration of such actions as laughing yawning or even biting

The condition is easily recognised The mouth cannot be shut—a permanent gap of about an inch remaining between upper and lower teeth In unilateral dislocation the point of the jaw is pushed across to the unaffected side There is an easily palpable abnormal depression in front of the ear Jaw movements are very limited speech and deglutition are interfered with and salivation is excessive

Reduction is usually easily effected by pressing the lower molars

downwards and backwards with the well guarded thumb inside the mouth After reduction a four tail bandage such as is used for mandibular fractures should be worn for a week There is little tendency to recurrence

Subluxation.—Subluxation of the joint—also called "clicking" or "locking" of the jaw—is due to a looseness of the intra articular cartilage This cartilage is dome-shaped to increase the height of the condyle of the mandible and to its anterior border is attached the tendon of the external pterygoid muscle If the cartilage is at all loose the pull of this muscle drags it forward so that it becomes pinched between the condyle and the eminentia articularis when the mouth is opened The cartilage itself is rarely torn but its catching in this position may lead to "locking" of the joint or in more chronic cases to an audible and palpable clicking Pain is in the early stages experienced locally and in the pinna to which it is referred via the stretched auriculotemporal nerve The joint can usually be easily freed by lateral movements of the jaw but in the frequent recurrent cases and in those in which the clicking interferes with talking and eating excision of the cartilage must be considered

Very rarely subluxation may result from the locking of loose bodies in the joint—usually the accompaniment of osteo-arthritis.

Trismus is a general term descriptive of the condition of inability to open the mouth. This may be due to a variety of causes which can be briefly summarised as follows —

1 Ankylosis of the Temporo-mandibular Joint —This may be either fibrous or osseous and results from arthritis due to such organisms as staphylococci streptococci, gonococci pneumococci typhoid and tubercle bacilli In an established case treatment consists in forming a false joint either by excision of the head or of a portion of the neck, followed by the insertion of a muscle graft from the internal pterygoid or masseter In such operations the danger of injury to the parotid gland, facial nerve and middle ear must be remembered.

2 Excessive Bone Formation in the neighbourhood of the joint This may be due to the callus of fractures articular proliferation following dislocation osteophytes of osteo-arthritis or osseous neoplasms particularly of the maxilla

3 Muscular Spasm, in such conditions as tetanus, hysteria or reflex irritation from acute arthritis of the temporo mandibular joint carious teeth and impacted wisdom teeth.

4 External Scarring in the neighbourhood of the joint resulting from bad burns lupus operations cancrum oris and the application of radium Myositis ossificans of the masseter muscle may be included under this heading Treatment in this type of case may rarely be possible by complete excision of the causative scar More usually an arthroplasty is required, the accepted method being that of Esmarch in which a wedge of the ascending ramus in the region of the angle is excised the apex of the wedge pointing towards the alveolus and a muscle graft inserted into the gap Occasionally the whole ascending ramus has been excised

5 Neighbouring Acute Inflammations (*e.g.*, parotitis, both

mumps and pyogenic Ludwig's angina lymphadenitis alveolar abscess, tonsillitis and stomatitis) The chronic fibrosis of actinomycosis may also be a cause

6 NEIGHBOURING NEOPLASMS—more particularly those of the parotid and maxilla

INFECTIONS

Acute.—1 SYNOVITIS—This is typically an accompaniment of rheumatic fever and its treatment as such is symptomatic. Other infective fevers *e.g* scarlet fever rarely give an acute synovitis of this joint with a tense serous effusion and trismus

2 ARTHRITIS—This is found as a complication of gonorrhœa, a non-suppurative type which requires only local conservative treatment and in pyæmia. In these latter cases the local signs of inflammation are well marked, and the general reaction is usually correspondingly severe Pus in the joint demands incision and drainage Very frequently this results in an ankylosis and subsequent excision of the condyle may be necessary A suppurative arthritis may also result from direct extension of pus from the parotid or more rarely in children from the middle ear

Chronic.—1 SYNOVITIS—This is most commonly the outcome of repeatedly recurring subluxation.

2 ARTHRITIS—(*a*) Osteo-arthritis is relatively frequent in this joint and is usually symmetrical. The mandibular condyle becomes flattened, enlarged and eburnated, and both the articular and intra articular cartilage tend to disappear Pain crepitus loss of movement and deformity make up the clinical picture In the typical bilateral cases the chin becomes pushed forward in unilateral cases to the unaffected side Loose bodies may be formed and lead to locking of the joint Treatment by physiotherapeutic and medicinal methods may give temporary relief, but in severe cases excision of the condyle should be seriously considered

(*b*) Tuberculous arthritis is quite well recognised in this joint both synovia and bone being attacked. The clinical resemblance to osteo-arthritis makes differential diagnosis very difficult unless other features of the case point to a specific etiology As immobilisation of this joint is virtually impossible earlier operation than is usual in other examples of joint tuberculosis should be undertaken to prevent sinus formation with its inevitable secondary infection

GUMS

HYPERTROPHY

This is a condition of fibrous overgrowth of the gums usually seen in young children It is practically always associated with the eruption of carious teeth and the patient is usually a weedy underdeveloped infant often mentally deficient The gum hypertrophy is very irregular the changes frequently being restricted to one side Mastication is interfered with salivation is excessive an external swelling may be obvious and bleeding is common The condition is very chronic, and

treatment may have to be repeated many times This consists in paring off the excess gum preferably by diathermy and extracting obviously carious teeth In resistant cases a small slice of underlying alveolar bone should also be removed

INFECTION OF THE GUMS

Spongy Gums.—This term which is in itself descriptive of the oedematous easily bleeding possibly ulcerated state of the gums seen in this condition should be restricted to those cases in which despite the secondary infection which inevitably occurs around the roots of the teeth the underlying etiology is either a fault in general nutrition (*e.g* scurvy and rickets) or a local chemical irritation (*e.g* overdosage of mercury or phosphorus poisoning) The treatment is essentially that of the underlying cause combined with the local use of astringent and antiseptic mouth washes

Gingivitis.—Bacterial infection of the gums may be specific or non-specific Of the former mention may be made of tuberculous and syphilitic types both of which arise by extension from the mucosa of mouth or tongue and of Vincent s spirillum infection The non specific form is more commonly called *pyorrhoea* or Rigg s disease All types of gingivitis are primarily due to lack of oral cleanliness. This in due course leads to a deposition of tartar on the gums around the crowns of the teeth and in this tartar bacteria find a most suitable nidus for development Another very common accompaniment is the habit of mouth breathing which, by drying up the buccal mucosa, prevents the natural salivary currents from cleansing teeth and gums

The commonest causal organism in pyorrhoea is the streptococcus, which gains entrance either via the coating of tartar between the gums and the crowns of the teeth, the infection slowly spreading through the periodontal membrane to the periosteum of the alveolus or through a carious tooth via the pulp cavity to the root leading to a periapical infection, a change which can be accurately recognised by X-ray examination. The condition affects adults and is very chronic the resultant absorption of toxins being responsible for many generalised infective conditions of the body The gums are discoloured congested and bluish they bleed easily are oedematous and tender and ultimately ulcerate This leads to the formation of mucosal pockets, in which suppuration takes place and from which pus can be squeezed. Later fibrosis occurs and the gums are retracted from the teeth which become exposed and frequently fall out The breath is typically offensive

The advent of penicillin has revolutionised the treatment of this condition. Clinically every patient can be apparently cured within three days but bacteriologically the continued presence of causal organisms suggests the probability of recurrence Penicillin is exhibited in the form of gelatin pastilles each containing 500 to 1000 units One dissolving in the bucco-gingival sulcus should last for approximately two hours, and eight are used during the day The subsequent use of penicillin tooth powder may obviate likely recurrences

Once the acute phase has passed dental surgery is still required and scaling extractions or gingivectomy should be carried out.

If the infection passes through a carious tooth to the apex of its fang a small *localised abscess cavity is formed in the substance of the* alveolus Such an *alveolar abscess* by pressure on surrounding bone leads to osseous absorption, and unless the pus has free outlet through the infected tooth socket the abscess will slowly track through the jaw and present externally This pointing usually occurs on the outer side of the jaw the bone on this side of the alveolus being thinner In this way a gumboil is formed. More rarely an abscess may *break through the palate or into the maxillary antrum* The condition is accompanied by severe pain of a throbbing character and the general reaction with high temperature is marked. The face in the neighbourhood of the abscess *is swollen the affected tooth* or teeth are loose and tender a certain degree of trismus is usual and the glands draining the area are enlarged and painful.

Treatment may be efficiently achieved in some cases simply by extracting the offending tooth, but more often incision of the gum and drainage of the cavity are required Antiseptic mouth washes should be used freely after either treatment Even so some residual infection is not uncommon and a chronic bone *cavity discharging small sequestra* via an external sinus is *formed* This requires more radical exposure and the establishment of efficient drainage

GROWTHS OF THE GUMS

Growths of the gums may be either innocent or malignant. The former are relatively common the latter as primary growths rare

Innocent Growths.—PAPILLOMA.—This is a small wart-like growth springing from the gums near the teeth The molar region of the lower jaw is that most frequently affected

Treatment consists *in local excision*

EPULIS —Two types of epulis are described the fibrous and the myeloid. The former is by far the commoner

The Fibrous Epulis is a fibroma springing in most cases from the periosteum of the alveolus It is slow growing and presents clinically as a smooth, often lobulated swelling on the outer aspects of the gums usually *of the lower jaw* Increase in size often takes place inwards between the teeth which may become completely *hidden by the* growth. This hypertrophic form is sometimes called a polypus " of the gum The association with dental caries is very constant but the growth *itself is painless and the only symptoms are those* due to its size which may be sufficient to interfere with mastication Treatment consists in local removal, together with the extraction of contiguous teeth if these are infected Recurrence is not uncommon in which case a small V-shaped piece of alveolus should be removed in conjunction with the growth

The Myeloid Epulis is a giant-celled tumour of the alveolar margin involving the gums. *It is similar pathologically to the* endosteal osteoclastoma of the jaw (p 97) but its characteristic position makes it a clinical entity It grows rapidly and either expands the alveolar

bone giving the typical egg-shell crackling feel when the outer plate of bone is sufficiently thinned or presents on the gum margin as a soft dark red swelling which after a time tends to ulcerate

Treatment involves opening the growth cavity scraping and painting the walls with carbolic or zinc chloride As recurrence is common this treatment should be followed by suitable radiation therapy Many surgeons prefer as a primary measure to excise a portion of the alveolus with the tumour

Malignant Growths.—Squamous-celled carcinomata round or spindle-celled sarcomata and melanomata have been reported as originating in the gums, but except as extensions from neighbouring parts, malignant growths are rare Excision where possible or failing this irradiation is the treatment of choice

TEETH

Development.—The teeth are ectodermal in origin being derived from downgrowths of the buccal epithelium into the mesoderm of the alveoli. Man has two complete dentitions The deciduous or milk teeth erupt at the following approximate dates central incisors 6 months lateral incisors, 9 months first molars 12 to 15 months canines 18 months to 2 years second molars 2 years This dentition is replaced, in girls earlier than in boys by the permanent teeth which erupt as follows first molars 6 years central incisors 7 to 8 years lateral incisors 7 to 8 years first premolars 9 to 10 years second premolars 10 to 11 years canines 10 to 12 years second molars 12 years and third molars, 18 to 22 years.

INFECTIONS

Dental Infection has to some extent been discussed in the consideration of pyorrhœa (p. 320) The causal organism is usually the streptococcus and this gains entry to the tooth via a carious surface on the crown Infection spreads through the pulp cavity giving necrosis this process being responsible for toothache Relief of pressure in the pulp cavity occurs via the apical foramen at the root and the subsequent course of events depends upon the virulence of the attacking organisms If this is marked bone infection is rapid and an alveolar abscess is formed (p 330) In milder cases a small periapical bone necrosis occurs, with a resultant chronic abscess cavity These can be recognised radiologically and their importance as a source of generalised chronic systemic toxæmia cannot be overstressed

Clinically following the initial acute toothache the affected tooth remains tender on pressure and this with or without accompanying pyorrhœa of the gums points to periapical infection, a diagnosis which can usually be confirmed by X rays Treatment consists in extraction of the affected teeth but a warning should be given against doing this in a wholesale manner So much toxin may be freed thereby as to render the patient acutely ill

Dental Cyst.—Dental cysts are discussed under the heading of teeth infections because of their invariable association with dental caries

dentigerous cyst no tooth recognisable as such The composite odontome is found in both jaws slightly more frequently in the upper It may grow to considerable size but is always easy to remove having very little apparent connection with surrounding bone

Radicular Odontome, as its name implies is formed in connection with one fang of a particular tooth It occurs in old people is usually quite small, and is characterised histologically by an absence of enamel

Fibrous Odontome —This is an uncommon type secondary changes in the wall of the dental sac producing layers of thick fibrous tissue



FIG 168

An X-ray of the face showing a tooth contained in a dentigerous cyst of the upper jaw It will be noticed that the crown is facing in the wrong direction.

in the midst of which in a relatively small cavity lies the unerupted tooth. It is frequently associated with rickets

Cementoma is also rare and is most simply described as a calcified fibrous odontome

The treatment of all these growths involves opening the pathological dental sac scraping out the contents breaking down all septa and clearing the walls The resultant cavity is flattened as far as possible carbolised and, if feasible covered with a mucosal flap If recurrence takes place a local excision of the affected portion of the jaw is indicated.

WISDOM TEETH.

The importance of the third molar lies in the frequency with which it gives rise to trouble Both the time and the method of its eruption are most irregular and very often either before or after eruption it becomes

carious If late in erupting it lies wedged behind the second molar and its extraction may be extremely difficult It is frequently considered advisable to remove the second molar and thus allow the wisdom tooth room to erupt rather than attempt a difficult extraction of this latter tooth itself The question of dealing with wisdom teeth is one in which the advice and assistance of a skilled dental surgeon should always be sought

EXTRACTION

This subject again belongs essentially to the realm of the dental surgeon, but in view of the emergencies that arise in ordinary surgical practice every student should familiarise himself with the different types of dental forceps their use and that of the dental elevator The latter which is used more particularly for the lower molar teeth and for stumps must be used with care as in inexperienced hands it can do much damage not only to gums but to the jaw itself and even the maxillary antrum. In any extraction a firm grip of the affected tooth should be taken with the particular forceps by insinuating the points between the tooth and the gums the tooth should then be loosened by gently rocking inwards and outwards and finally extracted towards the labial aspect of the jaw the outer alveolar table being thinner and *therefore less resistant*

Order and method are very important in multiple extractions In general it can be stated that lower teeth should be extracted before upper back teeth before front and stumps before whole teeth A system such as this keeps the field free of troublesome hæmorrhage as long as possible It is obviously necessary to remember the number of *fangs possessed* by each *particular tooth in order that stumps may not* be left behind

Nasal gas is probably the best general anæsthetic to use for dental extractions Chloroform should never be given with the patient in a sitting position. Local anæsthetics and blocking of the inferior dental nerve are extensively used.

Hæmorrhage from tooth sockets is usually slight and is arrested naturally in a few moments In cases where bleeding is prolonged *e.g* in hæmophilia scurvy purpura etc or after particularly difficult extractions where considerable laceration of the gums has occurred a warm astringent mouth wash should first be tried. If this fails recourse must be had to plugging the socket with adrenalin gauze and giving hæmoplastin. In really severe cases blood transfusion may be necessary

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CHAPTER XVIII

THE MOUTH, PALATE, TONGUE AND SALIVARY GLANDS

DEVELOPMENT.—The mouth is developed from the primitive stomodeum a depression of the ventral epiblast and is therefore lined by squamous epithelium The tongue makes its appearance as a small median elevation (the tuberculum impar) in the floor of the mouth which is soon joined at each side by lateral growths from the mandibular arches This develops into the buccal part of the tongue consisting of its anterior two-thirds The posterior or pharyngeal portion arises from the third branchial arches.

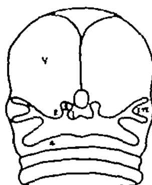


Fig. 169

Diagram showing the embryological structures taking part in the development of the palate.

1 The globular process; 2, The lateral nasal process; 3, The maxillary process; 4 The mandibular bar; 5, The nasal pit; C.V is the cerebral vesicle.

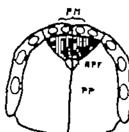


Fig. 170

Drawing showing the component parts of the hard palate.

P.M. is the premaxilla, and the shaded area represents that part of the palate derived from it; P P is the palatine plate N P.F is the naso-palatine foramen.

The development of the palate is a complex procedure. The fronto-nasal process appears as a median bud in the roof of the stomodeum. This bud is further differentiated into a median nasal and two lateral nasal processes. The latter have no further significance here but from the median nasal process are developed the nasal septum the premaxilla and the philtrum or middle third of the upper lip The premaxilla is derived from the anterior end of the median nasal process from which two protuberances jut forwards and downwards. These two globular processes later fuse together and form the anterior part of the hard palate and the central part of the alveolar margin of the upper jaw bearing all four incisor teeth. While these changes have been taking place the maxillary process is budding inwards and forwards from the upper border of the mandibular bar on each side From the buccal aspect of each maxillary process the palatine plates grow in towards the middle line fusing first with the premaxillary section

of the palate and then joining with each other and with the lower or free edge of the nasal septum This fusion takes place from before backwards and for this reason it is easy to explain why a partial cleft palate is more common than a complete lack of fusion (Figs. 169 and 170)

Surgical Anatomy—The buccal mucous membrane lines the inner aspect of the cheeks and lips the alveolar margins of both jaws and the palate It is continuous with the skin at the red margins of the lip and with the mucous membrane of the pharynx posteriorly It covers the floor of the mouth from which it passes to the under surface of the tongue and thence to the dorsum

The tongue is composed of an oral and a pharyngeal portion separated from each other by an inverted V-shaped groove which is marked on the dorsal surface by the circumvallate papillæ. Its anterior two-thirds is intrabuccal and its dorsal surface is covered by a rough thickened mucous membrane which is studded with both filiform and fungiform papillæ, while its under surface has a thin, smooth and glistening lining through which can be seen the ranine veins. The front half of the buccal portion is free and has considerable mobility The posterior part is attached by muscles and reflections of the mucous membrane to the lower jaw and by a median longitudinal fold the frenum, to the floor of the mouth.

The substance of the tongue consists of interlacing muscles, which are either intrinsic or extrinsic The latter provide attachment to the hyoid bone mandible and styloid process. The tongue is divided into equal halves by a median fibrous septum, which prevents any exchange of vascular or lymphatic circulation except at the tip The presence of this septum is indicated on the dorsal surface by a longitudinal groove which ends in the apex of the inverted V a point which is believed to represent the foramen cæcum *i.e.*, the site of origin of the thyroid anlage The muscles are supplied by the hypoglossal nerve Sensation is recorded by the glosso-pharyngeal nerve in the posterior third and the lingual in the anterior two-thirds, while taste is appreciated through the medium of the chorda tympani and the glossopharyngeal nerves. The arterial blood is carried to the tongue chiefly by the lingual arteries.

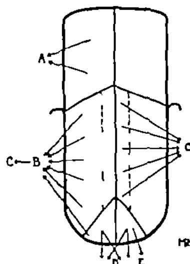


FIG 171

Diagram representing the lymphatic drainage of the tongue

A is the posterior third; B represents the submaxillary lymphatic group; C is the deep cervical group; D represents the submental group; and E an occasional lymph vessel draining to the lower deep cervical group.

The *lymphatic drainage* of the tongue has immense surgical importance and is arranged as follows (1) the apical vessels drain into the submental glands of *both* sides, the efferents of which pass to the deep cervical group, and an occasional vessel may go direct to one of the lower glands in the deep group (2) the lateral set drain that side of the tongue into the submaxillary lymph glands and thence to the deep cervical glands (3) the central set drain direct to the lower deep group (4) the posterior set pass through the superior constrictor muscle to the upper deep cervical glands. There is a certain amount of overlapping as Fig 171 shows.

The floor of the mouth is covered with thin smooth mucous membrane

behind the last molar tooth (Fig 173, A) Through this incision the mucosa is lifted from the bone in its outer two-thirds, the remainder being elevated through the inner edge previously made The soft palate is now mobilised by exposing the origin of the internal pterygoid



FIG. 173

A shows the paring of the edges. B demonstrates the elevation of the nasal mucosa (green), exposure of palatal muscles (red) and the fibrous band t the anterior end of the latter

muscle through the posterior part of the lateral cut and by using it as a guide to the hamular process the base of which is either fractured or cut through with scissors

4 LATERAL PHARYNGEAL MOBILISATION —On the inner surface of the internal pterygoid is an areolar space surrounding the pharynx.

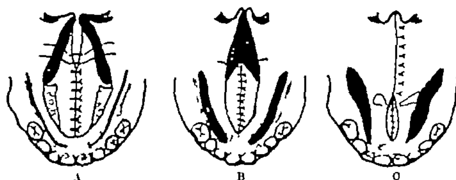


FIG. 174

Shows A, the lateral palatal incision and suture of nasal mucosa ; B, suture of palatal muscles ; and C, suture of buccal mucosa.

Blunt dissection in this space from either side further frees the soft palate Finally the lateral half of the palatal aponeurosis is divided from its attachment to the posterior border of the hard palate

5 SUTURING OF FLAPS —(A) In the nasal mucosa fine catgut stitches are inserted in such a way that the edges are inverted upwards into the nasal cavity (Figs 174 A and 175) This suturing is carried along the whole length of the cleft from front to back (B) The muscles of the soft palate are approximated by three stitches which must not

include either nasal or buccal mucosa (Fig 174 B) (*C*) Over the soft palate the buccal mucosa is brought together by a series of fine silkworm gut sutures introduced on an atraumatic needle That over the hard palate is stronger and will tolerate somewhat stouter gut (Fig 174 c)

A 1 2 3

B 1 2 3

Fig 175

Illustrating suture of nasal mucosa in A a unilateral and B a bilateral cleft.

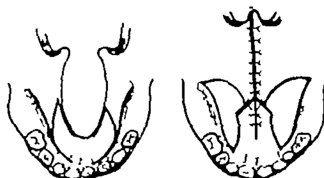


Fig. 176

Wardill's V Y operation.

Wardill s V Y Operation.—When the cleft is wide there is sometimes a shortening of the palate so that after repair the uvula and soft palate do not reach far enough back In such cases Wardill s operation is performed, the essential principles of which are seen in Fig 176 It will be accompanied by Wardill s pharyngoplasty

Methods of Narrowing the Nasopharyngeal Isthmus.—1 WARDILL'S PHARYNGOPLASTY —A transverse incision is made at the level of the transverse arch of the atlas into the posterior pharyngeal wall passing through the mucosa and superficial fibres of the superior constrictor This muscle is separated from the underlying buccopharyngeal fascia and the wound then sewn up vertically The result is to narrow the nasopharyngeal isthmus and raise an exaggerated Passavant's cushion.

2 DENIS BROWNE'S PHARYNGOPLICATION —A purse string is passed from one lateral relaxation incision behind the pharyngeal wall at the level of Passavant's cushion It emerges at the opposite palatal incision and is then passed through the soft palate and tied firmly In this way a ring suture encircles the nasopharyngeal isthmus and narrows it This stitch undoubtedly relieves tension upon the repair sutures in the palate but it is unlikely that it persists for a sufficient length of time to fulfil its primary purpose

These procedures are not essential in every case but are especially useful in short palates and in all patients in whom incompetence of the nasopharyngeal sphincter is to be expected

Special Techniques for Residual or Recurrent Clefts.—These are based upon the amount of tissue available and the degree of scarring They entail methods of lengthening the palate and mobilising flaps. Amongst them may be mentioned the Gillies Fry operation Moorehead's M and Dorrance's U incisions together with certain procedures in which flaps are swung from the cheek to cover a palatal defect

After treatment.—An intravenous drip of glucose-saline or blood is given during the first twelve hours Soft foods are allowed by mouth after forty-eight hours However the most important part of after-care is speech training and that should be in the hands of an expert

ULCERATION OF THE PALATE.—(1) Simple ulcers occur in association with stomatitis. (2) Secondary syphilis is responsible for snail track ulcers, while in tertiary syphilis a gumma in the midline is not uncommon, though much more rare to-day than formerly It is prone to spread to the underlying bone which becomes necrotic, and perforation of the palate follows. (3) Lupus spreads into the mouth from the face or nose but a tuberculous cold abscess is rare in this situation (4) Malignant ulcers are squamous-celled carcinomata

ABSCESS OF THE PALATE is either traumatic in origin or due to spread from the alveolar margin (gumboil) A painful, tender and fluctuant swelling appears and may require a small incision

PERFORATION OF THE PALATE is almost confined to tertiary syphilis, though rarely it may be due to trauma malignant neoplasms or lupus.

TUMOURS OF THE PALATE.—A simple papilloma is sometimes seen. An adenoma occurs as a small, smooth or lobulated swelling arising in the mucous glands of the mucous membrane and being similar in many respects to the salivary gland tumour It is removed quite simply

Malignant growths are primary or secondary the latter spreading to the palate from the tongue tonsils alveolar margins or antrum of Highmore The primary is a squamous-celled carcinoma which displays the characteristic appearance of malignant ulcers It should be removed as early as possible by diathermy

ELONGATION OF THE UVULA is usually seen in chronic pharyngitis, a hypertrophy of the mucous membrane taking place In the early stages

gargles and paints should effect a cure but later there is a troublesome cough If very long and definitely causing symptoms, the uvula should be cocainised and snipped off with scissors

THE TONGUE

CONGENITAL DEFECTS

Absence of the tongue has been reported but is very rare as is also bifid tongue Hemiatrophy is usually the result of paralysis of the hypoglossal nerve and not a defect in development

Partial Ankyloglossia, or Tongue-Tie is a condition in which the frenum is short and the movements of the tongue are restricted This is not a true pathological entity and purely an old wives tale that it can interfere with speech The sole justification for cutting the tongue tie is so marked a fixation that sucking is impossible In such cases the tongue is raised between the fingers and the frenum is snipped with blunt scissors near its attachment to the floor of the mouth

Complete Ankyloglossia is almost identical with absence of the tongue except in the acquired varieties in which it is due to extensive infiltration by inflammatory or neoplastic processes

Tongue Swallowing is the opposite of tongue-tie Not only is the frenum unduly lax but the tongue itself is relatively long A few *fatal results from asphyxia have been recorded*

Macroglossia.—Enlargement of the tongue may be classified as follows —

1 Lymphangiomatous
2 Muscular
3 Inflammatory
4 Syphilitic.
5 In endocrine disease.
6 In mental disease

CONGENITAL MACROGLOSSIA is due to a condition of cavernous lymphangioma throughout the tongue but is not necessarily obvious at birth. The process starts in one part of the tongue but spreads until the whole organ is affected. The tongue is symmetrically enlarged, the papillæ are hypertrophied and clear vesicles appear on the surface If untreated, it will become too large for the mouth and protrude through the lips being grooved and ulcerated by the pressure of the teeth

Treatment consists in a V-shaped resection with suture

MUSCULAR MACROGLOSSIA may occur very rarely in normal people but is usually seen in congenital idiots cretins or associated with various forms of gigantism It is present in acquired hypothyroidism (myxœdema) and in some forms of mental disease

Treatment is directed towards the cause but a wedge resection may be necessary to overcome protrusion and ulceration.

Inflammatory causes are those leading to recurrent attacks of acute glossitis Syphilitic macroglossia is a very rare *manifestation of* the disease to-day

INJURIES

The tongue may be severely bitten as the result of a fall or a blow on the chin or during the convulsions of epilepsy tetanus or strychnine poisoning A foreign body such as a pipe stem or fish bone may penetrate its substance The dangers are immediate hæmorrhage which can be very severe and a remote acute glossitis with or without abscess formation. The hæmorrhage can be temporarily controlled by hooking the tongue forward with the index finger Small wounds with moderate bleeding are cleansed and sutured but a really severe hæmorrhage may demand ligature of the lingual or external carotid artery

The tongue may also be injured by the stings of insects (*e.g* a wasp) or by being burned or scalded This may occur in small children who put their mouths to the spout of a boiling kettle These injuries lead to acute glossitis

THE INFLAMMATORY DISEASES OF THE TONGUE

Acute Superficial Glossitis is an inflammation of the mucous membrane and is merely part of an acute stomatitis (p 338)

Acute Parenchymatous Glossitis *affects men more than* women and follows penetrating wounds stings of insects infectious fevers or a severe stomatitis The infecting organisms are either staphylococci or streptococci and the condition, especially in the latter type of infection, is always grave The swelling which may be either unilateral or bilateral, comes on rapidly and may progress to such an extent that the tongue is indented and ulcerated by the teeth It is very painful, tender and indurated the breath is foul-smelling the submaxillary lymph glands are enlarged and there is a general febrile reaction

Treatment —Any obvious cause will receive attention and a brisk aperient be given Large hot dressings are applied to the neck and face frequent hot mouth washes should be used and in the intervals ice may be sucked. Penicillin or sulphadiazine should be given in full doses If the swelling continues to increase in spite of treatment, an incision is made in the dorsum on each side of the middle line Relief is instantaneous and hæmorrhage is slight Pain in the tongue or in the nerve distribution of the auriculo temporal may be so severe that morphia will be indicated

Complications —A localised abscess may form in the depth of the muscles usually after the more severe inflammation has begun to subside A tense and tender but rarely fluctuant swelling is present and will call for incision and drainage In the fulminating streptococcal cases gangrene of part or all of the tongue may follow

Chronic Superficial *Glossitis* *comprises a number of conditions* the most important of which are grouped under the heading of **Leukoplakia.** This is not confined to the tongue but affects any part of the buccal mucous membrane in which it may be seen while the tongue remains free It is rarely met with in women but affects men after the age of 45 years in the great majority of whom (over 90 per

cent) there is a history of syphilis There are however other predisposing factors among which are chronic sepsis in the mouth dental caries excessive smoking the drinking of raw spirits the eating of highly-spiced foods chronic dyspepsia and possibly gout

Naked-eye Appearance —Stage 1 Red hyperæmic patches appear as a result of swelling of the papillæ They are flat smooth and very slightly raised and need careful inspection in a good light before they can be critically defined

Stage 2 Hypertrophy and keratinisation of the patches some of which have coalesced to form round, oval or polygonal plaques now follow The plaques are white raised and firm though not indurated The term *ichthyosis* has been applied to this appearance (Fig 177)



Fig 177
Leukoplakia.

Stage 3 Interference with the blood supply beneath the white plaques by syphilitic endarteritis leads to shedding of the hypertrophied papillæ A smooth flat red and glazed patch results *Psoriasis linguæ* and the " red glazed tongue " are terms applied to this condition

Although the white plaque usually dominates the picture all three stages may be seen in different parts of the same tongue

Microscopic Detail —The underlying process is a chronic inflammatory reaction in the deeper layers of the mucous membrane and submucous tissues exhibiting a small round-celled infiltration and endarteritis in the small arterioles

Complications —**Fissures** are almost an essential feature in all long-standing cases of leukoplakia. The elevation of the keratinised plaques leads to the formation of clefts between them and small particles of food and clumps of bacteria are apt to be retained The subsequent irritation and infection cause linear ulceration or **cracks**, which do not yield easily to treatment This condition may justly be termed the threshold of lingual cancer for chronic ulceration and continued irritation coexist with an unstable state of the epithelium. It is claimed that one in every four sufferers from leukoplakia develops carcinoma of the tongue

Symptoms are dryness of the mouth constant discomfort pain in taking irritant foods or fluids and impairment of taste The pain is increased when the tongue is fissured and cracked.

Treatment —Leukoplakia is a most intractable disease and often progresses in spite of treatment

1 **Local**.—Every source of infection and irritation must be removed. The patient is referred to his dentist who must remain unsatisfied until every trace of dental sepsis is eradicated Smoking must be forbidden absolutely and alcohol is likewise prohibited. The diet is carefully restricted to avoid any possible source of irritation and,

Differential Diagnosis of Lingual Ulcers

	Dyspeptic.	Traumatic Dental.	Tuberculous.	Tertiary Syphilitic.	Neoplastic.
Situation	Any part of tongue and buccal mucous membrane	Edge usually towards the back.	Anywhere. Not confined to tip.	Dorsum.	Edge
Colour	Bright red.	Red.	Pale grey	Grey	Dirty grey
Depth and size	Shallow and small.	Moderate depth and moderate size.	Shallow. Moderate extent.	Deep. Large	Early—small. Late—deep and large.
Edges	Slightly oedematous.	Very oedematous.	Thin, pale and sinuous.	Clean cut.	Raised and everted.
Sides	Cupped	Sloping	Steeply sloping to meet in an angle.	Punched out. Right-angled.	Sloping.
Floor	Acute pyogenic granulation tissue	Sloughing. Acute granulation tissue.	Yellow floor. Walls covered with pale granulation tissue.	Pale pink indolent granulation tissue	Necrotic debris.
Discharge	Thick mucopus.	Thick mucopus.	Thin watery mucopus.	Very little serous.	Products of necrosis and mucopus.
Induration	Nil	Present but slight.	Nil	Present but slight.	Very marked.
Pain and tenderness	Exquisite	Marked.	Exquisite	Nil	Early—slight. Late—very severe
Local cause	Nil	Evidence of trauma. Jagged tooth.	Nil.	Nil.	? sign of irritation or injury
Other signs	Dyspepsia.	Nil.	Pulmonary and/or laryngeal tuberculosis.	Leukoplakia. Positive history	Possible leukoplakia. Marked limitation of movement.
Lymph glands	Nil	Nil, unless remaining untreated.	Enlarged usually contrary to usual teaching.	Nil.	Early—none. Late—moderate. Later still—very extensive

NEW GROWTHS OF THE TONGUE

Benign Growths.—Papilloma (Fig 178) is by no means uncommon shows no predilection for either sex or any age and may occur in any part of the tongue. It appears as a warty growth which may be surmounted by a thickened white epithelium — the leukoplakic papilloma It is not to be confused with the pseudo-papilloma due to hypertrophy in response to chronic inflammation The growth should be removed by diathermy



FIG 178
A papilloma of the tongue.

Several other rare and unimportant innocent tumours are seen (1) hæmangioma which occurs in children as a very vascular red area, sometimes of considerable extent (2) submucous lipoma and fibroma are seen beneath the smooth mucous membrane on the under surface of the tongue (3) the very rare rhabdomyoma and (4) the lymphangioma already referred to (p 345)

Malignant Tumours are carcinoma and sarcoma

LINGUAL CARCINOMA

Etiology—Cancer of the tongue is at the same time one of the most frequent and most fatal forms of malignant disease in the male It is possible that, with the greater participation of women in smoking and cocktail drinking the incidence in their sex will increase but at present it is rare although there have been five cases in St Mary s Hospital in the past six years. Chronic superficial glossitis is an acknowledged pre-cancerous condition, and other etiological factors include causes of irritation and sepsis in the mouth and persistent trauma such as is supplied by the sharp jagged edge of a carious tooth The buccal part of the tongue is more frequently affected than the pharyngeal area and usually the growth starts on the edge and overlaps on to the dorsum

Naked Eye Appearance is that of a squamous-celled carcinomatous ulcer (see diagnostic table p 350) Rarely it affects other guises such as a flat warty growth, a malignant papilloma, or an indurated area around a fissure between two leukoplakic plaques but however it first appears the typical surface ulceration will soon become evident (Fig 179)

Microscopic Detail is likewise characteristic the epithelial down growth, the formation of cell nests and the surrounding round-celled infiltration being present (Fig 40 p 107)

Method of Spread—At first the growth will be confined to the intrinsic muscles and during this period the movements of the tongue will remain unimpaired, but after a time the extrinsic muscles are invaded and movement on the affected side will be limited. The growth

can spread in many directions forwards to the floor of the mouth backwards to the fauces and pharynx laterally to the gums and alveolar margin and downwards into the neck.

Reference to Fig 171 will show routes of lymphatic spread In an inverted V-shaped area at the tip carcinoma will invade the submental *glands of both sides.* *Growths on the lateral area of the anterior* two-thirds spread to the submaxillary glands of the same side while the less frequent cancers near the midline drain direct into the upper and middle deep cervical glands of the same side and to a lesser extent to the opposite side also Eventually all growths involve the *deep cervical glands* whether the malignant cells have passed through intermediate glands on their way or not The glands become enlarged,

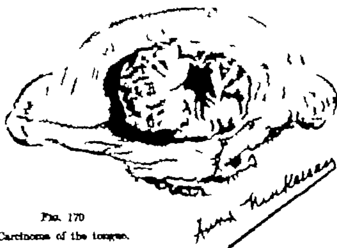


Fig. 170
Carcinoma of the tongue.

very hard and adherent to each other and to the internal jugular vein As the primary ulcer is invariably infected with secondary pyogenic cocci the lymph glands tend later to become infected and break down and if not treated, pus will erupt through the skin leaving necrotic ulcers in the neck

Distant metastases are rare but the local
that death comes as a merciful release Th
beyond eighteen months after the disease is
to either septic bronchopneumonia, hæmo
of starvation or exhaustion from pain and tc

Clinical Picture —In the early stages, a
with commencing ulcerati seen. T
no limitation of movem ie r
and no impairment of Th
curious feeling of stiff on,
pain on taking irritating

In the intermediate a
the breath fœtid and there
in the affected side so
towards that side because

blurred and difficult to understand Pain is becoming a prominent feature both in the tongue itself and in the referred area of the Vth cranial nerve especially in the distribution of the auriculo-temporal branch, that is to the ear the temporomandibular joint and the temple Enlarged lymphatic glands will be present in the primary drainage area.

In the later stages, the tongue has become fixed to the floor of the mouth and a large septic ulcerating growth is present Eating and swallowing are so painful that the patient hardly dare take any food. Saliva trickles steadily from the mouth and small hæmorrhages come from the growth at the slightest touch The lymph glands are greatly enlarged and may be breaking down. Pain is severe and the whole state constitutes one of the saddest pictures in malignant disease



FIG. 180

Carcinoma of the tongue.

Differential Diagnosis—The diagnostic table (p 350) serves to give the differential diagnosis in the case of the malignant ulcer The submucous nodule before ulceration should give rise to no difficulty because of its induration. Doubt should *never* be allowed to enter into this question. If there is the *slightest* uncertainty in the practitioner's mind a piece of tissue must be removed for microscopy

Treatment.—At the present time it is not easy to give an authoritative statement on the treatment of lingual carcinoma. Radium has not yet gained universal acceptance among surgeons as the method of choice and many still advocate radical removal of the tongue relegating radium to a subsidiary position for inoperable growths We however are convinced that radium has rather more to offer than surgery in the treatment of the primary lesion. Radium therapy should have a negligible operative mortality it is not a mutilating procedure and the function afterwards is good. The radium technique will be briefly outlined as well as some of the accepted operative methods.

Preliminary Treatment (all methods)—Intensive treatment must be directed to the eradication of every cause of buccal sepsis The teeth must pass a dental surgeon's examination or be removed. Constantly repeated antiseptic mouth washes are used during the day and it is wise to insist upon the patient being in bed in a nursing home for at least four days before operation.

Radium Therapy to the Tumour—For growths in the anterior two-thirds of the tongue radium needles (0 5 1 or 2 mg) are inserted into its substance beneath the tumour as shown in Fig. 181 They are stitched in position and the silk sutures are brought out of the

mouth and fixed to the face by strapping The dose must vary with the size of the growth, but an average exposure will be about 1750 mg. hours and owing to the small number of needles that can be usefully employed, they will have to be left in position for from seven to ten days Patients suffer considerable discomfort, but severe pain should be absent. Diet will have to be limited to fluids for the first four days and soft semi-solids afterwards. A careful watch is kept each day to estimate the reaction. It is wise to have a general anaesthetic for the insertion of the needles, but they can be removed under pentothal.

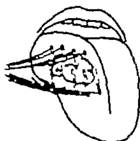


Fig. 181
Diagram illustrating the method of implanting radium needles in the tongue.

Growths in the posterior or pharyngeal part of the tongue are preferably treated by the bomb (Cade) because it is exceedingly difficult to gain an adequate enough view or access to be certain that the needles have been inserted in such a way that they are irradiating the whole growth.

Treatment of the Glands is an absolutely essential part of the technique. It should be postponed for fourteen days after the insertion of the needles and must *never* be carried out *before* the irradiation of the primary tumour

A Glands not palpable External irradiation is obtained either by a radium collar or deep X-ray therapy

B Glands palpable but operable. A complete block dissection of one or possibly both sides of the neck (though not upon the same occasion) followed by prophylactic X ray exposures constitutes the best treatment available.

C Glands palpable and inoperable Cade advises the combination of interstitial needling and external irradiation.

Operative Treatment.—1 Growths near the tip. The anterior half of the tongue is removed by dividing it with the diathermy needle and either at the same time or preferably after ten days the *submaxillary and submental glands of both sides of the neck* are completely dissected away Prophylactic X ray therapy to the deep cervical glands follows.

2 Growths of the anterior two-thirds on or near to the edge The tongue is split down the middle line and the anterior two-thirds of the affected side removed, diathermy again being used. The unaffected side can be sewn round to the stump on the affected side Ten days later a *block dissection of the cervical glands of the same side follows* This amounts to a modification of the original Whitehead's operation, and is always to be preferred to Kocher's extrabuccal removal.

3. Growths near the middle line The whole of the anterior two-thirds of the tongue must be removed and the glands on both sides of the neck are dealt with either at the time or ten days later

4. For posterior growths Syme's operation entails the splitting of the lower jaw through the symphysis and gives access to the root of the tongue and the attachments of its muscles to the hyoid bone. The whole tongue is removed.

Inoperable Growths should invariably be treated with radium. The prognosis is inevitably hopeless but an effort must be made to clear up the growth in the mouth with the object of saving the patient from some of the worst of his pain and sepsis

SARCOMA is a rare disease of the tongue occurring either in children or adults. It may be a round-celled fibrosarcoma but rare cases of rhabdomyosarcoma have been recorded It may form a large swelling protruding from the surface (Fig 182) or give rise to a generalised enlargement of the tongue

Treatment is by radium therapy



FIG. 182

A sarcoma of the tongue.

LINGUAL CANCEROPHOBIA.—So many patients come for advice who present a perfectly normal tongue for examination, that a few words of advice may prove helpful. The majority are women, who are haunted by the fear of cancer and, having discovered their circumvallate papillæ for the first time imagine these to be a tumour Others have found cracks and fissures so infinitesimal that the professional eye cannot detect them whilst others complain of neuralgic pain. If the underlying phobia is recognised, the patient can usually be readily convinced of her safety when the comparative immunity of her sex to cancer of the tongue is put to her but a great deal of harm can be done if the phobia passes unsuspected and palliative treatment ordered, for the patient is then more than ever convinced that she has cancer and that the doctor is afraid to tell her or that he has failed to recognise its presence

CARCINOMA OF THE FLOOR OF THE MOUTH is so closely allied to lingual carcinoma that it is best described here It takes the typical form of the squamous-celled ulcer which spreads into the frenum and so reaches the tongue It does not appear to have so high a mortality rate as cancer of the tongue but it is important to recognise it before it has invaded that organ or infiltrated the periosteum of the lower jaw

Treatment consists in removal of the anterior third of the tongue

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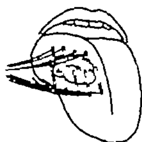


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Treatment consists in removal of the anterior third of the tongue

the floor of the mouth and the alveolar margin of the mandible corresponding to the eight central teeth The glands of the submaxillary and submental regions are removed at the same operation. The use of radium in these cases is contraindicated as it is difficult to protect the lower jaw from necrosis The operation is followed by X-ray therapy to the deep cervical glands on both sides of the neck.

THE SALIVARY GLANDS

Surgical Anatomy—**The Parotid Gland** fills in all the spare space between the mastoid process and the ramus of the lower jaw It rests on the styloid process and posterior belly of the digastric muscle is limited above by the zygoma and the external auditory meatus, and in front it spreads out over the masseter muscle It is enclosed in a capsule derived from the deep cervical fascia, and so firm is the anterior layer of this capsule that swelling of the gland is rendered difficult.



FIG. 183

Right-sided parotid "sialogram."

The parotid gland is intimately related to the facial nerve which runs through its substance in which it divides into its many branches. The deeper part is in contact with the IXth Xth, XIth and XIIth cranial nerves and the termination of the external carotid artery

Stenson's duct leaves the anterior margin of the gland, runs over the masseter to gain its anterior edge, round which it dips to pierce the buccinator muscle and so open on the mucous membrane of the mouth opposite the second molar tooth of the upper jaw It lies one finger's breadth below the zygoma and can be palpated when the masseter is made tense

The Submaxillary Gland lies under cover of the body of the lower jaw in its posterior half It has two parts, a large superficial portion lying beneath the deep fascia and a small deep lobe under the mylohyoid muscle. Wharton's duct passes forwards from this deep portion to enter the floor of the mouth and opens on the summit of a papilla to one side of the frenum of the tongue. The submaxillary gland is intimately associated with lymphatic glands which lie in the hollow between its two parts.

The Sublingual Gland lies beneath the mucous membrane of the floor of the mouth on either side of the frenum Several ducts of Rivini open into the mucous membrane of the floor of the mouth

Methods of Examination.—In addition to surface palpation, bimanual examination with one finger in the mouth is of great help, especially for the submaxillary gland In cases of doubt a sialogram taken after injection with uroselectan gives valuable information (Fig 183)

Injuries of the Salivary Glands are not uncommon but as they usually heal without complications they provide little surgical interest, except in the case of the parotid gland, which cannot be removed

owing to the number and the importance of the structures which traverse it

FISTULA OF THE PAROTID GLAND is usually due not to a wound but to suppuration in the gland around a calculus or in association with an ascending parotitis An incision for drainage having been made a sinus persists after the wound has otherwise healed and clear saliva is discharged, particularly at meals This type of fistula usually heals spontaneously though very slowly It is wise to accelerate healing by cauterisation with a diathermy needle and if this should fail irradiation with radium will quickly bring about the desired result.

FISTULA OF STENSON'S DUCT is a far more difficult problem but is fortunately a rare occurrence It is almost always traumatic in origin the duct being cleanly severed and after a time its buccal end becomes shrunken and atrophic The best treatment is immediate end to-end suture over a few strands of silkworm gut which protrude into the mouth But this is not often possible because the salivary injury is not recognised till later When the fistula lies in front of the masseter the duct should be freely opened into the mouth by incising the buccal mucous membrane widely The saliva flows without hindrance into the mouth and the cutaneous opening should heal

If the fistula is on the surface of the masseter near the gland, the problem is one of great difficulty Plastic operations are to be attempted gradual reconstruction of the distal part of the duct with a small rubber tube being later followed by closure of the fistula. If all methods fail the secretion can be finally inhibited by avulsion of the auriculo temporal nerve

Inflammation of the Salivary Glands—THE PAROTID GLAND —A. *Epidemic Parotitis* or Mumps is an acute infectious fever and its description will be found in textbooks of medicine

B *Simple Parotitis* is a subacute catarrhal inflammation of one or both glands as a result of cold, injury or the presence of a calculus The gland swells up is painful and tender There is a mild pyrexia and slight constitutional disturbance and within a few days the condition has subsided.

C *Acute Suppurative Parotitis* is more serious The organisms reach the gland either by ascending Stenson's duct from the mouth, by direct spread from the jaw or other neighbouring structure or by the blood stream in typhoid, scarlet fever and pyæmic diseases It is still occasionally seen (but far less so than in the past) as a complication of abdominal operations as a result of extreme dryness of the mouth, lack of oral feeding and inattention to buccal hygiene

The gland enlarges rapidly and becomes very painful and tender The skin is red and œdematous Owing to the density of the capsule fluctuation as a clinical sign is very late in appearance All movements of the jaw are painful, constitutional disturbances are marked and the patient is seriously ill If outlet is not given to the pus it will track in several directions all of them dangerous for example toward the external auditory meatus the pharynx, the base of the skull the deep muscles of the neck and even possibly down to the mediastinum

Treatment—It is obvious, therefore that it is most unwise to wait

for fluctuation before making an incision. The pus must be given thorough drainage and all loculi must be broken down by digital manipulation. Adequate dosage of penicillin will in many cases avoid the need for surgery.

THE SUBMAXILLARY AND SUBLINGUAL GLANDS may likewise be the seat of acute inflammation but less frequently than the parotid. The infection may be secondary to oral sepsis or to the presence of salivary calculi. If chemotherapy fails to produce rapid resolution early incision is advisable lest œdema of the glottis or Ludwig's angina appear as dangerous complications.

Von Mickulicz' Disease is a rare condition in which all the salivary and the lachrymal glands take part in a slow painless and symmetrical enlargement. The etiology is unknown, except that in a very few patients there has been a definite association with lymphatic leukæmia. Except in these cases treatment is by X-ray therapy.

Salivary Calculi form most commonly in the submaxillary gland or its duct and somewhat rarely in the parotid gland and its duct. They are composed of calcium phosphate and carbonate deposited on a nucleus of mucus and epithelial debris. They show some tendency to occur in members of the same family.

STONES IN THE DUCTS do not cause complete obstruction as a general rule so that saliva can leak past them except at times of great activity namely at meals. The symptoms are attacks of pain along the duct, especially during the taking of food, and a rapid swelling of the gland as soon as the meal is commenced. This swelling slowly subsides in the interval between meals and some patients learn to hasten this subsidence by pressure upon the gland. On examination, the mouth of the duct will be seen to be red and œdematous the calculus can be felt between the fingers or by a probe passed up the duct and it is rarely necessary to have an X-ray photograph.

Treatment consists in removal of the stone by making a small incision over it in the duct through the mucous membrane of the mouth.

STONES IN THE GLAND SUBSTANCE.—Stones form in the submaxillary gland more frequently than is usually thought, and their clinical picture does not include the somewhat dramatic swelling at each meal time. They give rise to a dull aching pain at first and then later recurrent attacks of subacute or chronic sialo-adenitis occur. Slowly the gland becomes enlarged thickened and painful and is so fibrous that it may be impossible to say confidently that the stone can be felt an X ray photograph being needed to confirm its presence (Fig 184).

Treatment consists in removal of the submaxillary gland.

If stones are allowed to remain either in the ducts or in the glands for any length of time there is always the danger of an acute ascending infection from the mouth. This will cause an acute sialo-adenitis with or without pus formation, and for this reason all salivary calculi should be removed as soon as possible.

A Ranula is a cystic swelling in the floor of the mouth to one side of the frenum. Its exact origin is undecided, but it has no connection with the salivary glands since its contents are devoid of salivary ferments. It arises probably as a retention cyst in the glands of

Blandin and Nuhn or in that of Bochdalek or it may possibly be an error in development of the mucous membrane of the floor of the mouth It forms a soft fluctuating smooth round swelling which may be so large as to displace the tongue upwards and to one side. Its characteristic blue colour serves to distinguish it from a dermoid cyst

Treatment —The wall is so thin that it is not possible to excise the cyst intact The mucous membrane over it is incised and the projecting walls of the cyst are removed with scissors flush with the level of the floor of the mouth The remainder of the cyst wall is destroyed by diathermy and the cavity allowed to granulate from the bottom.



A



B

Fig. 184

A, a patient with chronic sialo-adenitis of the left submaxillary gland due to a calculus shown in an X-ray B.

Growths of the Salivary Glands.—Benign growths are limited to the so-called "Mixed Parotid" tumour unfortunately named in that it is neither pathologically mixed nor anatomically confined to the parotid gland

The Salivary Gland Adenoma, as it should more correctly be called, is quite common in both sexes It does not usually appear before the age of 25 years and is of exceedingly slow growth. Although most frequently seen in the parotid, it may arise in the other salivary glands and in the lachrymal glands whilst ectopic tumours may occur beneath any part of the buccal mucous membrane where mucous glands exist.

The tumour has a smooth lobulated surface is white or gray in colour firm and elastic in consistence and on cross-section bears a resemblance to the fibro-adenoma of the breast (Fig 185) *Mucoid* degeneration may cause many small cystic spaces or the whole swelling may be converted into one large cyst This latter type is usually met with in that part of the parotid gland lying deeply behind the ramus of the mandible

Microscopically the tumour has the character of a true adenoma of mucin-secreting epithelium The areas of mucoid degeneration present certain staining reactions which bear a superficial resemblance

to cartilage and this accounted for the theory of their "mixed" origin.

Clinically.—After many years of very slow growth they may suddenly take on rapid growth suggestive of a malignant change. They present no symptoms and cause no disability save a somewhat unsightly swelling.

Treatment.—The adenoma should always be removed in spite of its slow growth and apparent benignity. Although the tumour has a definite capsule it is fairly firmly adherent to the gland tissue and *careful dissection is needed. It is essential that the whole adenoma be* removed and no part of the capsule left behind but it is equally





A B

FIG. 185

Salivary gland tumour

A, before removal; B, after removal, showing cut surface.

important that injury to the facial nerve be avoided. If any doubt exists concerning the completeness of the removal it is wise to leave one needle of radium in the cavity for five days: in this way a recurrence can be definitely prevented.

Ectopic tumours are most commonly seen on the palate beneath the mucous membrane of which they project as round, firm masses of small size being of slow growth. Very occasionally such ectopic tumours take on rapid growth and, without becoming malignant, grow into and largely destroy the upper jaw. All such tumours should be removed in an early stage.

MALIGNANT GROWTHS *are exceedingly rare. The majority arise as a* malignant change in a previously existing adenoma, and the others as spontaneous growths. The signs of malignancy in the parotid are the hardness of the swelling, pain and the involvement of the facial nerve. It is most unlikely that any treatment will be possible except X-ray or radium therapy. *Complete extirpation may be attempted.*

The salivary glands, especially the submaxillary, are liable to invasion by other malignant processes such as carcinoma of the tongue and the floor of the mouth.

R. M. HANDFIELD-JONES.

CHAPTER XIX

THE SURGERY OF THE NECK

ANATOMY.—The reader is referred to textbooks for the detailed anatomy of the neck, and only certain relationships of surgical significance are described here. The Cervical Fascia envelops the neck and sending two fibrous sheets across it, forms three compartments. The enveloping or superficial layer is attached behind to the ligamentum nuchæ splits to enclose the trapezius joins again to roof in the posterior triangle, and splits to enclose the sternomastoid muscle At the anterior margin of this muscle the fascia spreads across the middle line to meet the other sternomastoid and so forms the fascial space of Burns. The prevertebral layer passes in front of the spinal column and its muscles, and the pretracheal layer extends across the neck in front of the larynx, trachea and thyroid gland giving off subsidiary lamellæ to form the carotid sheaths The anterior compartment is therefore purely muscular leads to the bones of the shoulder girdle and has no connection with the chest. The middle compartment contains the pharynx, larynx, trachea, thyroid gland and carotid sheaths and communicates with the superior mediastinum. The posterior compartment contains the spine vertebral muscles and nerves it forms the posterior wall of the superior and posterior mediastina. The significance of these fascial paths of connection with the chest lies in the possibility of the spread of infection from the neck.

The development of the neck presents certain important features. In the third week of intra uterine life pairs of branchial arches are formed in the post-oral area with clefts between them. They consist of mesoblast and are covered with epithelium on either side Fusion with each other and across the midline with those of the opposite side occurs quickly If this fusion is imperfectly completed various anomalies are seen in the neck. The component parts of the head and neck which arise in the various arches and clefts are —

1 From the 1st arch the mandible the processus gracilis of the malleus, the mandibular division of the Vth nerve and the muscles of mastication.

2 From the 1st cleft, the Eustachian tube tympanic cavity external auditory meatus and the Glaserian fissure

3 From the 2nd arch, the styloid process stylohyoid ligament lesser cornu of the hyoid bone VIIth nerve and the muscles it supplies

4 From the 3rd arch the body and great cornu of the hyoid bone IXth nerve and its muscles.

5 From the 4th arch the remaining structures of the neck.

6 The 2nd, 3rd and 4th clefts are obliterated but the 2nd is represented by the fossa of Rosenmuller and the 3rd by the pyriform fossa of the larynx.

ANOMALIES OF DEVELOPMENT

Branchial Fistula

These fistulæ or sinuses also known as Lateral Fistulæ of the Neck, or Persistent Cervical Sinuses are due to imperfect closure of the branchial clefts Only rarely are they true fistulæ opening into the pyriform fossa or nasopharynx being usually sinuses opening on the skin along the anterior border of the sternomastoid muscles near the clavicle and passing upwards inwards and backwards for a limited distance They are lined with columnar epithelium, and secrete a scanty glairy mucoid fluid. They are usually present at birth, and are sometimes associated with other anomalies, such as accessory auricles and facial clefts. The majority will require no treatment, but if the discharge is a source of worry they should be dissected out If the fistula is complete the pharyngeal end must be invaginated.

Branchial Cysts

During the process of closure of the clefts small islands of cleft membrane (either 2nd or 3rd cleft) may be cut off and left in the developing mesoblast, These cell inclusions may be derived from the external cleft membrane (the future skin) or the internal membrane (the future lining of the pharynx and larynx) If later they should grow they form branchial cysts which have thin walls and are lined either by squamous or columnar epithelium The contents of the former are thick semi-solid sebaceous matter rich in fat and cholesterin crystals and of the latter a glairy mucoid fluid They may retain an attachment to the wall of the pharynx by a thin fibrous cord which passes between the internal and external carotid arteries

Clinically they become obvious between the tenth and twenty first year and are often preceded by an injury which presumably galvanises the cell inclusion into active growth They are commoner in males and on the left side of the neck. Those derived from the 3rd cleft lie between the anterior border of the sternomastoid muscle and the lateral ala of the thyroid cartilage and reach the greater cornu of the hyoid bone. The rare 2nd cleft cyst is higher up in relation to the mastoid process and the jaw These cysts are never really *tense* and fluctuation is readily detected, but one of their chief characteristics is that they vary in size from time to time They have no fixed attachment in the neck, and lose their marked mobility only when they become infected. The correct treatment is removal, as they may become the seat of a branchial carcinoma.

Thyroglossal Cysts

The thyroglossal duct" (p. 372) is a solid column of cells stretching from the foramen cæcum of the tongue through the genio-hyoglossi muscles to the hyoid bone anterior to which it passes in front of the larynx to reach the thyroid isthmus. This tract should

disappear completely but may persist in two situations viz. the tongue and the neck.

In the tongue a nodule of thyroid tissue may be present near the foramen cæcum forming a dark red mass beneath the mucous membrane. It is discovered usually during routine examination of the mouth and throat for some buccal or pharyngeal disease. This nodule may be the only thyroid tissue present and must not be removed until the presence of a normally placed gland is confirmed.

In the neck thyroglossal cysts (Fig 186) are seen in the midline either just above or more commonly below the hyoid bone. The cyst is lined with embryonic thyroid tissue and contains a colloid substance. It appears in children of both sexes about the age of five and presents fluctuant rounded smooth swelling over which the skin moves freely. It may be firmly fixed to the hyoid bone and if so will move on swallowing. Those above the bone in the muscles of the tongue will move more obviously upwards and backwards when the tongue is protruded. If opened or allowed to burst, a median cervical sinus is formed.



Fig 186
A thyroglossal cyst.

Treatment consists in complete removal, and the operation is apt to be tedious and difficult, the percentage of recurrences being high. If the cyst is attached to the hyoid bone then no effort should be made to dissect it free but the body of the bone excised with the cyst.

Cervical Rib

A supernumerary rib arises usually from the 7th cervical vertebra and very rarely from the 6th. This cervical rib may be little more than an exaggeration of the costal element of a transverse process; it may be a short fine rib projecting hardly beyond the scalene muscles; it may pass downwards and forwards being connected with the first rib by either a short fibrous cord or true bony fusion; and lastly it may have a true costal cartilage uniting it with the sternum. The latter two varieties emerge between the scalenus anticus and medius muscles, the former of which usually gains an attachment to the abnormal rib. The brachial plexus and the subclavian vessels pass over it (Fig 187).

Cervical ribs are frequently bilateral; when unilateral they are more common on the left side but symptoms are more often present on the right. Women are more frequently affected than men. Symptoms are absent in many patients, the rib being discovered in a routine examination, but in any event they do not appear until the age of 18 years. This is explained by the gradual descent of the shoulder girdle upon the thoracic cage which occurs during adolescence. Sargent found that symptoms were usually more severe upon the side of the smaller rib owing to the more intense compression by the narrow taut fibrous cord.

Symptoms are grouped as sensory motor and vasomotor They are aggravated by carrying heavy weights certain types of work, wearing heavy clothes and certain games *e.g* golf and are relieved by rest and elevation of the arm.

A Sensory Patients frequently complain of tingling in the hands and fingers particularly in the tips of the latter These symptoms may be unilateral, a point of considerable importance in diagnosis. They are referred to either the ulnar or radial side rather than to the whole hand. Pain is felt in the forearm hand or fingers radiating in a downward direction It is sharp and lancinating and may be brought on by a sudden rotation of the head or a forceful downward pull of the shoulder On the other hand it may be dull aching or burning in character occurring late in the day when the patient is tired

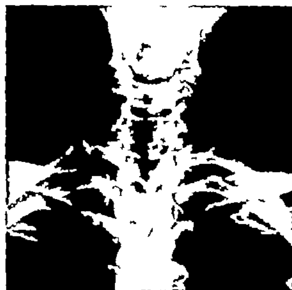


Fig 187
A well-marked right cervical rib, short rudimentary one on the left side.

General sensibility is impaired and there may be actual anaesthesia. This does not always coincide with median or ulnar distribution or indeed with a typical root supply

B Motor There is an increasing loss of power in the hand with inability to perform fine movements The muscles affected may be either those supplied by the median or ulnar nerve They show wasting to a variable extent—sometimes to a marked degree

C Vasomotor These are due to pressure on the sympathetic fibres in the lower roots of the plexus rather than to direct compression of the nerves themselves. The affected forearm and hand are cold and assume a dusky hue and there are mild trophic changes in the finger tips A diminution in the volume of the radial pulse is sometimes noted and this may be accentuated by inspiratory movements of the chest and relieved by raising the arm above the head. Gangrene of one or more fingers has been described Occasionally the subclavian artery may be seen pulsating above the clavicle

Diagnosis.—Similar symptoms are often seen in patients with syringomyelia and progressive muscular atrophy A careful clinical investigation should arrive at a correct diagnosis which is confirmed by X-rays Most abnormal ribs can be demonstrated in the films.

Treatment.—When a cervical rib is causing no symptoms treatment is not indicated. Young people in whom there are slight symptoms

benefit greatly from exercises designed to increase the tone and power of trapezius and levator scapulæ muscles The resulting bracing up of the shoulder girdle relieves the strain upon the nerve as it crosses over the abnormal rib

In cases with severe symptoms the rib must be removed or the fibrous band divided

The Scalene Syndrome

A clinical picture suggestive of cervical rib is not infrequently seen in patients who present a normal X ray appearance and in whom an abnormal band is not found Symptoms are rarely so severe as with a true cervical rib and they appear usually at a later age often about 40 years. Tingling pain down the arm is sometimes marked especially after active exercise and such routine daily occupations as needle-work, knitting car driving etc may be curtailed. This syndrome is due to one of two conditions. The majority of these patients have a short contracted scalenus anticus muscle (and possibly medius) which elevates the first rib sufficiently to cause mild pressure upon the nerve the remainder suffer from an abnormality of the brachial plexus and not of the ribs In a post fixed plexus a normal first rib bears a relation to the lower cord comparable to that of a normal cord to a cervical rib consequently pressure is exerted by the rib upon the nerve

Treatment —Many of these patients are relieved if the insertion of the scalene muscle is completely erased from the first rib which is thus allowed to fall to a lower level. Others will require removal of a major part of the first rib to relieve pressure upon the nerve

Torticollis

Wry neck is characterised by lateral inclination of the head towards one shoulder accompanied by torsion of the neck and deviation of the face towards the opposite side It may be either congenital acquired spasmodic or hysterical.

Congenital Torticollis.—It is generally held that during a difficult labour temporary acute obstruction of the veins in the sternomastoid muscle of one side occurs and this may be rendered permanent by intravascular clotting This latter and the resultant effusion is apparent in infancy as the so-called sternomastoid tumour The swelling eventually disappears its place being taken by fibrous tissue which later contracts. The mechanism, therefore is comparable to that which produces ischæmic contracture of the forearm. During difficult labour especially a breech presentation one sternomastoid muscle may be torn and a hæmatoma forms with similar sequelæ to those described above It can hardly be said, therefore to be truly congenital and it is doubtful if any case can be traced to a developmental defect

Clinical Features —In the first few weeks of life an elongated swelling is seen in the lower half of the affected sternomastoid muscle This is tender and the child cries when the muscle is stretched or palpated Both swelling and tenderness disappear slowly but towards the end of the first year the muscle is seen to be unduly tense owing

to the fibrous tissue in its substance As this contracts still further the head is drawn down so that the ear on the affected side is pulled towards the sternoclavicular joint while the face is rotated to the opposite side If treatment is not instituted early a gradual atrophy of the face on the affected side develops All soft parts on this side shorten while the bones of the cervical and upper thoracic spine acquire a fixed scoliotic deformity

The condition is easily diagnosed In many cases there is a history of difficult birth followed by a tender swelling in the neck. Later the typical deformity of the sternomastoid is obvious

Treatment —In mild cases the deformity may be prevented if treatment is given at an early stage It is not wise to manipulate and stretch the tender muscle but as soon as the child is strong enough the tumour should be excised. In very slight cases manipulation and exercises are sufficient.

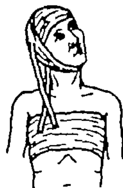


Fig. 188

Torticollis, showing method of application of bandage after operation.

If the child is not seen until after the age of 2 years an open operation is necessary The contracted part of the muscle is divided ½ in. above the clavicle and the cervical fascia may need similar treatment The head is placed in an over-corrected position and retained there by bandage or plaster (Fig 188)

During the six months following operation, active and passive exercises must be carried out to prevent any recurrence of the deformity

Acquired Torticollis is due either to "rheumatic fibrositis following exposure to colds or draughts (the common stiff neck) or to reflex causes, such as inflammatory lesions of adjacent lymph glands or spinal caries of the cervical vertebræ. It is always essential that these causes should be eliminated before treatment is considered

Spasmodic Torticollis.—This type occurs in adults and is a very obvious and distressing condition. The sternomastoid and trapezius on one side acting in conjunction with the posterior rotators on the other produce violent jerking movements of the head, which is suddenly and forcibly pulled into the typical torticollis position. At first some control can be exercised by the patient but later movements are quite involuntary and may even spread to other muscles, such as those of the shoulder and face

This condition is undoubtedly of organic origin the lesion being either of the peripheral nerves or more probably of the midbrain. Roger and Pourtal found that five of their patients had lesions of either the pyramidal tract or the extrapyramidal system.

Treatment —Sedative drugs and re-educative exercises may afford some relief while fixation of the head in a plaster jacket may help. In severe cases operation should be advised this consists in resection of the spinal accessory nerve of one side and of the posterior primary divisions of the first three cervical nerves on the other This has given great relief in a certain number of patients.

Hysterical Torticollis.—Habit spasms and certain jerking movements of the head are sometimes seen in hysterical young women A careful analysis of these movements will show that they rarely conform exactly or consistently with those of spasmodic wry neck Treatment is directed to the underlying neurosis

INFLAMMATORY CONDITIONS IN THE NECK

CELLULITIS OF THE NECK (Ludwig's Angina)—This is either a streptococcal infection having origin in some focus in the teeth, tongue floor of the mouth jaw tonsils larynx or pharynx or it may be a complication of an acute infectious fever *e.g* scarlet fever or diphtheria The infection first passes to the submental or submaxillary lymphatic glands and then spreads in the tissue planes below the jaw It is characterised by a brawny œdema in which pus forms slowly and in small amounts If unchecked, infection spreads throughout the neck with grave symptoms of constitutional involvement. Eventually extension occurs into the mediastinum, leading to mediastinitis pericarditis and empyema. Other complications which may usher in a fatal ending are septic venous thrombosis, pyæmia, meningitis and œdema of the glottis

The Clinical Picture in the early stages shows a dusky red swelling beneath the jaw with brawny œdema *Although pus forms, it will* rarely give fluctuation and pointing does not occur The patient is in great pain and the swollen area is exquisitely tender There are high fever rapid pulse and rigors Œdema of the glottis is an ever present danger which may at any time become urgent and demand a tracheotomy

Treatment—The original focus should be identified and dealt with The local condition may be treated at first by hot dressings, short-wave therapy sulphadiazine and penicillin, but if the swelling is increasing one or more incisions must be made No inhalation anæsthetic is safe and pentothal should be used, and even that must not be started until a tracheotomy set is sterilised and at hand. Several small incisions are better than one large one they must go through the deep fascia and pus be sought for Even if no pus is found they allow a profuse drainage of infected blood-stained serum In severe cases the general condition of septicæmia is grave and demands active treatment

(Boils carbuncles and other infective processes will be found under their specific headings in other chapters)

INJURIES

Cut-throat.—Cut-throat may be suicidal or homicidal. Owing to the medico-legal aspect exact observations of each case must be recorded In attempting suicide by this method, the victim throws back his head, and in so doing renders the air passages more prominent and tenses the sternomastoid muscles behind which the carotid vessels obtain some protection. A right-handed man begins the cut on the left side draws the knife straight across the midline and tends to

finish the cut in an upward direction on the right side Unless he is very determined the cut becomes shallower as it progresses. A *left-handed suicide* produces his injuries in the reverse direction. In a homicidal case the extent and nature of the injury depends on the relative position of assailant and victim and on the hand used. Most attacks are made from behind and the cut is usually shallower at its commencement and deeper at the end or it is of equal depth throughout. The wound is more severe than in suicidal cases and the carotid vessels are more likely to be severed. In some cases the knife has reached the vertebral column and even entered the inter vertebral disc. In superficial cuts all important structures may escape injury and only the anterior and external jugular veins be opened. If the platysma is divided, the wound retracts and hæmorrhage may be profuse though easily controlled. In deeper injuries a rapidly fatal hæmorrhage ensues from a severed carotid vessel

The factor which has most influence on treatment and prognosis is involvement of the air passages If they escape the problem is simply that of general wound treatment If they are affected the condition becomes grave owing to the danger to respiration.

The Symptoms and Treatment depend on the site of injury

A **Above the Hyoid Bone.**—In this rare injury the extrinsic muscles of the tongue may be divided, the floor of the mouth opened, and the lingual and facial arteries and the hypoglossal nerve severed. The dangers are either immediate in that the damaged and possibly paralysed tongue may fall back and block the entrance to the larynx, or remote when the opening in the floor of the mouth makes infection of the wound certain.

B **Through the Thyrohyoid Membrane.**—This is the common site of injury The membrane is divided, the pharynx opened and the epiglottis injured. The lingual, facial and superior thyroid arteries and the hypoglossal nerve are likely to be cut. Respiration will be unaffected unless either the injured epiglottis or loose folds of mucous membrane obstruct the larynx, or blood trickles down into the trachea. Speech and swallowing are painful and difficult, and saliva will leak into the neck, rendering severe sepsis a probable sequela.

C **At the Level of the Larynx.**—Wounds in this situation are seldom severe as the density of the cartilage prevents the knife entering deeply The vocal cords may be affected and bleeding from the superior pole of the thyroid profuse Speech is difficult and painful, and blood may enter the trachea.

D **Through the Trachea.**—The narrowing of the air passage, which takes place at the origin of the trachea, allows the main vessels to swing in towards the middle line Injuries in this position therefore tend to produce serious effects Hæmorrhage may occur from the vessels of the thyroid gland and from the carotid and jugular trunks and will prove rapidly fatal. Blood may enter the trachea and be aspirated into the lungs and air be sucked into the great veins The œsophagus and recurrent laryngeal nerves may be injured and if the skin wound and the tracheal opening do not correspond, surgical emphysema results.

In all wounds of the neck the immediate dangers are hæmorrhage suffocation and to a lesser extent air embolism The later complications are sepsis in the planes of the neck and bronchopneumonia Sepsis in the neck may be introduced by a dirty weapon or come from the mouth pharynx or air passages The lungs are affected by aspiration of blood and food The mortality is high in suicide cases because these unfortunate people are usually in no state to combat a general or a pulmonary infection. Later sequelæ include tracheal and laryngeal stenosis and fistula from the œsophagus or air passages

Treatment—The general principles of wound treatment and arrest of hæmorrhage are applicable here Excision of the damaged tissues is carefully performed and the wound cleansed but although it may be sutured in layers drainage *must* be provided The wounds in the air passages will be treated as follows —

1 Wounds through the thyrohyoid membrane and above the hyoid bone The epiglottis is carefully sutured and the mucous membrane repaired after which the various layers are sewn up with drainage If respiration is embarrassed a high tracheotomy is performed.

2 Through the larynx The wound is sutured and a high tracheotomy performed.

3 Through the trachea. A tracheotomy tube is inserted in the tracheal wound and the opening sutured if necessary The rest of the wound is sewn up in layers Wounds of the œsophagus should be sutured and a drainage tube put down to the site Difficulty in swallowing may be due to injury of the epiglottis and loss of sensation in the pharynx and larynx. If any trouble is threatened an œsophageal tube should be used for feeding or a gastrostomy performed.

These patients are nursed in a semi reclining posture with the head well flexed on to the chest The usual general remedies for shock and loss of blood are employed, full chemotherapy instituted and a close watch kept for the earliest signs of sepsis counter-openings for drainage being made if needed. Precautions must be taken to prevent suicidal patients from interfering with the dressings

Other Injuries in the Neck.—Contusions of the skin of the neck have little significance except from the medico-legal aspect. Pressure of the fingers and nails usually leaves marks which can be recognised, and a cord tied round the neck for strangling or hanging bruises the skin in a peculiar manner Direct blows cause widespread bruising which may be very extensive in run-over accidents.

The subcutaneous lesions may be restricted to hæmorrhage beneath the cervical fascia, but be sufficient to cause urgent dyspnœa and dysphagia. In the more severe injuries the laryngeal cartilages and trachea may be bruised or torn, leading to immediate or delayed suffocation, and in all such injuries the danger of œdema of the glottis cannot be dismissed for forty-eight hours Fracture of the cartilages when calcified occurs but rarely and then in old people The treatment of all subcutaneous injuries in the neck is expectant a tracheotomy being performed at any time within the first few days if required.

CYSTS IN THE NECK

These may be classified as follows —

A. In the Middle Line of Neck		Dermoids.
		Thyroglossal cysts.
		Sublingual ranula.
		Adenoma of thyroid isthmus.
		Subhyoid bursitis.
B In the Side of Neck	Developmental	Branchial cysts.
	Salivary	Submaxillary retention cysts.
	Lymphatic	Lymphatic cysts.
		Cystic hygroma.
		Chronic abscess in glands.
		Cystic growth in glands.
	Vascular	Aneurysm.
		Venous cyst.
		Serous cyst.
	Thyroid	Cystic adenoma.
	Parasitic	Echinococcal.
	Neoplastic	
	Aerocele.	
	Pneumocele	
C. Anywhere in Neck	Sebaceous cysts	

Dermoid Cysts.—Sequestration dermoids are sometimes seen in the midline of the neck between the hyoid bone and the jaw They are lined with squamous epithelium and contain soft pultaceous matter They are seen in children, are of small size and are not attached to the skin or deep structures but may project between the mylohyoid muscles and form a swelling in the floor of the mouth They can be removed with ease

Sublingual Ranula.—This will rarely push its way between the mylohyoid muscles and appear in the neck. A bilobed swelling is seen with a narrow channel between the buccal and the submental portions They have all the characteristics of the ordinary ranula (p. 358) and should be dissected out.

Lymphatic Cysts (Hydrocele of the Neck)—These are unilocular cysts of moderate size occurring in the lower part of the neck and in the axilla. They are congenital in origin and are seen in children under the age of ten years as soft, lobulated, usually translucent flabby cysts which are liable to undergo recurrent attacks of mild inflammation, causing them to become more tense and a little painful. In the quiescent periods they give rise to no symptoms but nevertheless should be removed.

Cystic Hygroma.—Much confusion has existed in the past owing to the vague nomenclature of lymphatic swellings in the neck, and the term cystic hygroma is used by some authors to cover all lymphatic cysts. It is better to limit it to a rare condition which is seen in infants in whom there is an overgrowth of lymphatic tissue resulting in a large swelling in the neck which is riddled with small cysts This may stretch from one mastoid process to the other below

the jaw and down to the clavicles axillæ and mediastinum Attempts to remove them usually fail owing to their ramifications but injection of the cysts with sodium morrhuate may succeed in causing a reduction of the swelling

Cystic Swellings of the Lymphatic Glands.—These include acute and chronic abscess and the cystic degeneration of new growths They are discussed in Chap XVI

Subhyoid Bursa.—A small bursa occupies the postero-inferior aspect of the hyoid bone lying between it and the thyrohyoid membrane When enlarged it may be mistaken for a thyroglossal cyst It is firmly fixed to the hyoid moves on swallowing and its long axis is transverse If it is unsightly or painful it should be removed

Aeroceles.—These are diverticula from the larynx or trachea and are not true cysts. They are resonant and reducible and are popularly supposed to be common amongst trumpeters and the Mohammedan *muezzins*

Pneumatoceles.—These are herniæ of the apex of the lung into the supraclavicular triangle



FIG. 189

A carotid body tumour The common carotid artery is seen bisected and dividing into its two terminal branches.

MALIGNANT DISEASE IN THE NECK

In addition to growths of the ordinary structures in the neck there are two rare varieties to be described, branchial carcinoma and tumours of the carotid body

Branchial Carcinoma (Branchiogenetic Carcinoma) is a very rare condition seen in elderly men. It is a squamous-celled growth arising in a branchial-cleft cell inclusion or in a pre-existing branchial cyst. It forms a hard, rapidly growing mass between the sternomastoid muscle and the hyoid bone becomes fixed to surrounding structures and then infiltrates diffusely in the upper part of the neck. It is more compact and smooth than a fused mass of secondary malignant glands, and there may be the history of a pre-existing cyst which has suddenly taken on rapid and solid growth. It causes some pain but is otherwise symptomless and metastasises quite late Attempts at removal are usually unsuccessful, and radium or deep X ray therapy should be tried.

Carotid Body Tumours are endotheliomata of two varieties One is a slowly growing vascular tumour described as a perithelioma and the other is a more malignant and very hard growth named the potato tumour They envelop the carotid arteries the internal jugular vein the vagus and sympathetic nerves but in spite of this they give no symptoms The diagnosis is usually

impossible except by microscopy Treatment is excision which may have to include important vessels and nerves (Fig 189) The dangers of cerebral anaemia are so real after this operation that it is better to try the effect of radium or deep X-ray therapy first

THE THYROID GLAND

Anatomy—The thyroid gland consists of two lateral lobes and an isthmus The lobes are conical with their bases downwards and measure about two inches in length extending from the lower part of the ala of the thyroid cartilage above to the fifth ring of the trachea below They are moulded to the larynx and trachea on their postero-internal surfaces, while superficially they are smooth and rounded. The isthmus unites the lateral lobes across the front of the trachea at the level of the second and third rings. The whole gland is enveloped in a fibrous sheath derived from the pre-tracheal layer of the deep cervical fascia, which is attached above to the thyroid cartilage It is covered by the sternohyoid, sternothyroid and anterior belly of the omohyoid muscles. The thick rounded, posterior border rests on the pharynx or oesophagus and the recurrent laryngeal nerve and laterally overlaps the carotid sheath The pyramidal lobe is not always present, being a narrow strip of thyroid tissue arising from the isthmus just to the left of the midline running upwards along the trachea and thyroid cartilage It may end in a fibrous cord attached to the hyoid bone—the suspensory ligament of the thyroid gland.

The superior thyroid artery is a branch of the external carotid and, running downwards meets the apex of the lateral lobe where it divides into two branches an external branch passing down the lateral surface to anastomose with branches of the inferior thyroid artery and an internal branch along the inner border which reaches the upper surface of the isthmus to anastomose with its fellow from the opposite side The inferior thyroid artery is a branch of the thyroid axis trunk from the first part of the subclavian. It reaches the posterior aspect of the lower pole of the gland dividing into several branches which enter it along its postero-lateral border Among these branches the recurrent laryngeal nerve ascends to the larynx. The thyroidea ima artery is an inconstant vessel which arising from the aortic arch or from the innominate artery reaches the inferior aspect of the isthmus. The inferior and middle thyroid veins collect blood from the lower poles, the left joining the left innominate vein and the right entering one or other innominate vein or the junction between the two The nerves are derived from the sympathetic plexuses which accompany the arteries and the lymphatics enter the pre-tracheal and inferior deep cervical glands

The thyroid gland develops from a median and two lateral buds. The median one arises from the fused ventral ends of the second branchial clefts and grows downward in front of the larynx. It forms the isthmus and the major part of the lateral lobes. The lateral buds are developed from the fourth clefts and form thin caps to the median growth thus completing the lateral lobes. The track of the developing median bud stretches from the foramen cæcum at the back of the tongue down to the isthmus, thus constituting the thyroglossal duct

Method of Examination—The patient should be placed in a semi-reclining position with the neck partly flexed and so supported that the muscles are completely relaxed. Difficult cases should be examined from behind so that the thyroid can be pressed back against the transverse processes by the

examining fingers. Thyroid swellings are recognised by their upward movement on swallowing and as some patients find it difficult to swallow at will they should be given some water to drink if any doubt exists A few other swellings move on deglutition but are so rare that they may be disregarded The extent and consistence of any swelling are noted and any prolongation into the mediastinum can be mapped out by percussion and by X rays which latter will show the tracheal displacement and possibly a shadow of the swelling The rate volume and regularity of the pulse and the condition of the heart muscle are next investigated The outstretched fingers are examined for tremors the eyes for the signs associated with exophthalmic goitre and finally the basal metabolic rate is estimated. The metabolism of the body may be expressed in terms of heat output and under conditions of muscular rest and fasting the figure is constant This constant is known as the basal metabolic rate (hereinafter termed the B.M.R.) which may be defined as the number of calories produced per square metre of body surface per hour under standard conditions Clinically this is estimated indirectly by the amount of oxygen absorbed and carbon dioxide produced in a given time It is known that the B.M.R. is affected by changes in thyroid activity It is plotted from a normal constant of zero plus figures denoting hyper thyroidism and minus figures the reverse A variation of from -10 to $+10$ is regarded as being within normal limits.

Anomalies in Form.—Accessory thyroid bodies may be found in the deeper areas of the neck, and are developed as offshoots from the median thyroglossal duct The pyramidal lobe is a persistence of the lower end of the thyroglossal duct while thyroglossal cysts and sinuses arise in the upper end of the duct In very rare instances the only thyroid tissue present will be found as a swelling at the back of the tongue (p 349)

Anomalies in Function.—The absence or deficiency of thyroid secretion in children leads to a form of dwarfism named cretinism. Growth is stunted, body fat is increased, particularly over the shoulders the face is pale flabby and expressionless mental development is backward and the children are unclean in habits If it is recognised before two years of age thyroid medication will permit the development of an almost normal child, but the later the diagnosis is made the less marked is the improvement and the worse the end result

Hypothyroidism in adults is produced by the removal of the thyroid gland or by its destruction from disease The condition is called myxœdema, in which there is an imperfect removal of mucin from the body which becomes fat and heavy The face is white and waxy the expression dull and vacant, the skin dry and the hair falls out. The tongue is enlarged and sore and the voice altered. There is a slow pulse a subnormal temperature and a dulling of all mental faculties Sexual power and desire are lost. The administration of thyroid extract restores these patients to normal in a wonderfully short time

Hyperthyroidism is a condition exemplified by exophthalmic goitre and toxic adenoma, under which headings it will be discussed.

ACUTE THYROIDITIS

This is a very rare disease Joll reports two cases in over 2000 goitre admissions, and only two patients of this type have been seen

in St Mary's Hospital during the last twenty years There is
evidence to suggest that a goitrous gland is more susceptible to infec
than a normal one Acute thyroiditis may follow acute infection
the mouth, fauces pharynx and neck, acute infectious fevers or r
from embolism in pyæmia In almost every example organisms
either blood or lymph borne Two types are seen, suppurative
non-suppurative

Suppurative Thyroiditis starts abruptly with pain and throbb
either the whole gland or one lobe becoming swollen and tender I
fever and rigors follow and are rapidly succeeded by difficulty
swallowing breathing and talking It is an exceedingly dange
disease owing to the risk of spread to the mediastinum. Treatn
consists in energetic chemotherapy and free incisions which n
provide adequate drainage

Non-suppurative Thyroiditis has a more gradual onset its sympt
are less severe and after a few days (usually seven to ten) resolu
occurs and the gland returns to normal

CHRONIC THYROIDITIS

Chronic pyogenic, tuberculous and syphilitic disease are exceedin
rare and merit no description here

Reidel's Disease.—Ligneous thyroiditis or woody thyroid is
common, *but is more frequently recognised as its clinical picture*
pathological appearance are more widely understood. It is cha
terised by a dense sclerosis which destroys the gland substan
moreover it shows a marked tendency to spread outside the cap
and involve neighbouring structures, such as the carotid sheath in
hyoid muscles trachea and œsophagus Further it so invades
tissue planes that normal structures become impossible to de
exactly The disease usually starts in the lower pole either upon
surface destroying the gland by strangulation, or within its substa
replacing the vesicles by infiltration It may spread to the wh
gland or one lobe may remain unaffected

Nothing is known of the causation or nature of the disease bey
the fact that it is inflammatory in type and definitely not neoplasti

Clinical Picture.—*The sexes are affected almost equally during*
years of active adult life Pain and dyspnœa are the chief sympto
the latter being severe and out of all proportion to the size of
swelling Dysphagia and interference with the voice are commo
met with. The swelling is not of great size, unless the disease has ari
in a previously goitrous gland, its surface is smooth and regular and
regional lymph glands are not involved The striking feature is
stony hardness in which it excels even a scirrhous carcinoma
spite of extensive destruction of gland tissue signs of hypothyroidi
are not seen.

Treatment is directed solely to relief of pressure upon the trach
and œsophagus (Joll) *An operation directed to this end is fraught wi*
both difficulty and danger but it is the only procedure we have to off
Radiotherapy can do no good.

Lymphadenoid Goitre or Hashimoto's Disease.—Although many authorities regard this as an early stage of Reidel's disease there are strong grounds for the belief that it is a clinical entity It consists in a diffuse infiltration of the gland with lymphocytes in women over 45 years of age The gland becomes uniformly enlarged and although fibrosis occurs later there is never the same degree of hardness as in ligneous thyroiditis Most of these patients eventually show signs of myxœdema

Treatment—If a correct diagnosis is made surgical treatment is contraindicated When myxœdema threatens appropriate thyroid medication will be required.

PHYSIOLOGICAL HYPERPLASIA OF PUBERTY

A slight increase in size of the thyroid occurs temporarily at puberty each menstrual period and during pregnancy A more obvious and persistent enlargement is commonly found in girls about the age of puberty It is noticed first at the age of about 14 years and continues for periods varying from eighteen months to three years A similar condition occurs rarely in boys The swelling is regular and homogeneous and consists in a true hyperplasia of normal thyroid tissue It is due to an attempt by the thyroid to make good a deficiency in secretion of one or more members of the endocrine group which fail to respond to the increased demand that puberty makes upon them. The swelling is symptomless and slowly disappears leaving no trace of thyroid disease rarely however subsidence of the hyperplasia unmasks an adenoma No treatment is needed, the only important thing being to reassure the parents that the condition is temporary

SIMPLE GOITRE

Joll classifies simple goitre thus —

1 Parenchymatous } Diffuse or symmetrical.
2 *Colloid* }

3 Nodular { (*a*) Diffuse or multiple
{ (*b*) Localised or single

Etiology—Simple goitre is either endemic or sporadic Nothing is known of the cause of sporadic cases which occur under conditions quite antagonistic to the development of endemic goitre The etiology of the latter is imperfectly understood and we are ignorant of any specific factors leading to the variation in type It is instructive to consider some of the facts and theories which command serious attention.

1 Distribution —Endemic goitre occurs in many parts of the world. The "goitrous areas in Great Britain are the south west counties of England Hereford, Warwickshire Gloucestershire Derbyshire Cheshire and Nottingham, parts of Wales and a small area of Scotland in Europe the whole Alpine range from Savoy to Austria the plains of Northern Italy and the Pyrenees in America the mountain districts of the Pacific seaboard and the plains around the Great Lakes in the Himalayas in Egypt and in New Zealand.

2. Iodine Deficiency.—The thyroid gland is associated with iodine metabolism and in many districts the prevalence of goitre corresponds to an iodine deficiency in soil, water and food. The successful use of iodine as a prophylactic agent in the prevention of goitre is a strong argument in favour of this theory. Excellent results have followed the experiment in America of adding a trace of iodine twice monthly to the communal water supply and also in Switzerland where widespread propaganda urges the inhabitants of the mountain valleys to use iodised salt, tea and chocolate.

3. Water Contamination.—MacCarrison has proved conclusively that goitre can be produced by giving animals or humans water from known goitrous springs. He has shown that if such water is filtered, no ill-effects are experienced, but that a solution of the scrapings from the filter candles does produce goitre. Further he quotes a military school in the Punjab in which the incidence of goitre was between 60 and 80 per cent until in 1918 a new water supply was installed, after which the rate dropped to 2.2 per cent within three years. Instructive as this work is, it does not prove that water pollution is an active etiological factor in goitre production throughout the world.

4. Infection.—There is no evidence to uphold theories that a specific living organism is responsible.

5. Heredity undoubtedly plays a part. Many goitrous districts are composed of isolated communities in whom intermarriage is unavoidably prevalent. Endemic goitre has a high incidence in children of goitrous parents, and if this inbreeding is continued from one generation to another goitre becomes an established characteristic in the children.

6. Other Contributory Factors are a diet having an excess of protein and calcium, unhygienic condition of living and possibly lack of sunlight. Finally MacCarrison suggests that goitre may be due not only to a deficiency of iodine and other substances, but also to an inability of the tissues to utilise them when present in normal amounts.

It cannot be said that any one theory so far satisfies critical analysis.

Parenchymatous Goitre

Etiology.—Joll defines this type of goitre as one "due to an increase in the epithelial elements without any appreciable colloid accumulation." It is found in areas of high endemicity, e.g. the mountain valleys of Switzerland, where iodine deficiency and water pollution are prevalent. It is uncommon in this country. It occurs in children and adolescents of both sexes and may be present as a congenital lesion. It is not usually seen after the age of 20 years because by that time it is likely to have become a colloid or nodular goitre.

Pathology.—The change affects the whole thyroid, though one lobe may be larger than the other. The gland is enlarged to moderate size and is firm and vascular; its surface is slightly lobulated. Essentially the pathological process is an overgrowth of epithelial elements,

the vesicles being small and irregular The colloid and iodine content of the gland is reduced

Symptoms —At first there is a symptomless swelling readily identified as affecting the whole thyroid gland It has a smooth lobulated surface is solid elastic and homogeneous Later compression of the trachea causes dyspnœa and stridor and in the later stages signs of dysphagia and myxœdema may occur



Fig 190
An elderly woman with a huge colloid goitre.

Treatment is needed only to relieve pressure and for cosmetic reasons A bilateral partial thyroidectomy should be performed.

COLLOID GOITRE

Etiology — Diffuse colloid goitre occurs in areas of low endemicity e.g England and Wales and the region of the Great Lakes of America It is seen in both sexes commonly between puberty and 30 years though in some parts it may occur at an earlier age

Pathology —The whole gland is affected, being enlarged often to a considerable size (Fig 190) Its surface shows marked lobulation On section it shows a honeycombed appearance (Fig 191) and sticky colloid oozes from it Microscopically there are seen greatly distended vesicles lined by flattened cells and full of colloid. The iodine content is much in excess of normal, though actually it is less in proportion to the size of the goitre

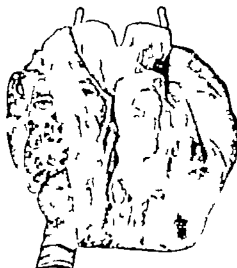


Fig. 191
Colloid goitre showing general appearance and cross-section.

Many transitional types between this and nodular goitre will be seen the cut surface showing increasing degrees of lobulation until the gland seems to be filled with numerous encapsuled swellings

Symptoms —Retrosternal prolongations are common in this

type of goitre which also tends to spread behind the trachea and encircle it Compression of the trachea with dyspnoea is therefore earlier in its appearance than in the parenchymatous form Later many of these patients exhibit signs of a moderate degree of thyrotoxicosis

Treatment is directed to relief of pressure improvement of the patient's appearance and prevention of thyrotoxicosis by partial thyriodectomy

NODULAR GOITRE

Generalised Type.—Although histologically incorrect the term multiple adenomatous goitre graphically described the appearance of this, the commonest of all endemic goitres. It occurs in all areas in patients of both sexes from the age of 30 onwards, whilst in long-established goitrous localities it may be seen in young subjects.

Pathology—This goitre often grows to great size and as its name implies has a markedly lobulated surface with large veins coursing over it Unlike other varieties it is frequently asymmetrical, although changes are present throughout the gland Its cut surface presents a picture of multiple adenomata surrounded by fibrous septa These masses may be more or less uniform in size but more probably vary greatly The adenomata are pale pink in colour and show the characteristic semi translucent appearance due to colloid. Degenerative changes will be seen in older lesions hæmorrhage and cyst formation being common Microscopical appearances vary widely from greatly distended vesicles with flattened epithelium to solid colloid free adenomatous structures. Some of the vesicles exhibit epithelial hyper plasia to such an extent that the picture may closely resemble that found in primary thyrotoxicosis

The clinical picture and treatment are similar to those of colloid goitre

Localised Type.—Great controversy still ranges around the exact pathological status of the single localised encapsuled swelling appearing in an otherwise normal thyroid gland Joll includes them amongst the nodular goitres. Such tumours do occur without any change naked-eye or microscopic in the rest of the gland For this reason I prefer to classify them as true neoplasms, and they will be described later (p 384).

THYROTOXICOSIS

PRIMARY THYROTOXICOSIS

Exophthalmic goitre or Graves disease is a condition in which thyrotoxic symptoms are due to changes affecting a previously normal gland. It is believed that this disease does not originate in the thyroid gland, but typical changes are produced in it which lead to a characteristic clinical picture It is generally held that the toxic substance circulating in the blood is a perverted thyroid secretion but Joll believed that in addition there must be also an element of hyperthyroidism, *i.e.* an excess of thyroxine in circulation. We remain in ignorance of

the basic causes of this disease but certain facts and theories repay consideration

Etiology—1 Generally speaking this disease is uncommon in most endemic goitre districts, but this is not true of this country Here the incidence of the two conditions is high in goitrous districts although Graves disease is distributed widely throughout the whole country

2 Women are more frequently affected than men in the ratio of 10 1 but after the age of 50 this falls to 6 1 Nulliparous women are more susceptible than their parous sisters

3 The highest age incidence is between 25 and 45 years a number of cases occur in girls between puberty and 24 years after 45 years there is a sharp fall.

4 Causation. *A* Heredity as far as we know plays no part in this disease *B* As some of the symptoms can be produced by stimulation of the sympathetic nervous system, it has been suggested that an imbalance between the two sides of this system may be the underlying cause but the theory is untenable. *C* Other workers seek to incriminate both adrenal and thymus glands but in neither case can the argument be upheld The thymus is considerably enlarged in about 21 per cent. of cases of Graves disease but the exact nature of this association is unknown (Fig 193) *D Focal sepsis especially in the fauces and* pharynx and acute infectious fevers such as influenza can undoubtedly lead to exophthalmic goitre The former is exemplified by a patient suffering from acute streptococcal tonsillitis who developed a severe attack of thyrotoxicosis with a high B.M.R and who rapidly recovered after tonsillectomy *E* Psychological factors anxiety worry sexual maladjustments and emotional disturbances appear in the histories of so many patients that this association cannot be merely coincidental. Joll regards this aspect as being overrated and observes that most patients will give a story of psychic trauma I feel that the evidence though circumstantial is too strong to ignore In some patients at least it is probably the strongest etiological factor



FIG. 193

A specimen showing the appearance of the thyroid in exophthalmic goitre with an enlarged persistent thymus.

Pathology—Iodine medication and radiotherapy produce marked changes in the thyroid gland in Graves disease and the following description is of the untreated gland

1 Naked-eye appearance The degree of thyroid enlargement varies greatly but it is never so pronounced as in simple goitre indeed

it may be quite trivial. It is necessary to emphasise, however that there is always some enlargement It is paler smoother more solid and compact than normal and there is a marked increase in vascularity out of all proportion to its size On section the surface is uniform in colour and consistence being pale pink, of solid appearance and showing no suggestion of colloid (Fig 192)

2 Microscopically the acini are irregular and the epithelium undergoes marked hyperplasia The cells are several layers deep and many are columnar in type The vesicles become full of cells and little or no colloid can be seen while in some sections the acini are completely solid

It is right to add that the histology of primary thyrotoxicosis varies considerably and the above description though typical, does not cover the whole ground. In some cases little or no epithelial hyperplasia can be found and colloid appears to be normal in amount



Fig. 193
An unusually large swelling in exophthalmic goitre causing dyspnoea.

Iodine medication and X rays both produce greatly increased fibrosis and the former leads to a definite increase of colloid in the gland

Symptoms—Graves disease is rather more chronic than is frequently taught. Dunhill has pointed out how large a percentage of his patients come to him with a history of five to ten years Untreated it tends to pass through a cycle of changes of exacerbation and improvement and at one time an attempt was made by Plummer to utilise the periodicity as an indication of prognosis and of the most favourable time for operation The behaviour of these patients is too capricious for any such classification. A few cases are of a rapid fulminating type and die within a few weeks. On the other hand, very few patients recover spontaneously

Symptoms may be grouped as —

A Pressure

B Toxic { Nervous, Cardiac, Alimentary }

C Ophthalmic.

D General { Loss of weight, Menstrual disorders, Metabolic changes. }

A Pressure Symptoms are unusual because the thyroid rarely enlarges to any size In some cases there may be dyspnoea (Fig 193)

B Toxic Symptoms.—*1* Nervous. These patients are in a highly nervous excitable state reduced to a fever of apprehension by the approach of a stranger or of a doctor to examine them In the early stages they find that work previously easy cannot be faced and small difficulties cheerfully surmounted before now become impossible the effort leaving them exhausted with a mental fear of impending disaster The slightest strain upsets them and they are subject to waves of cutaneous vasodilatation in which a red flush spreads from the face

o neck and chest Sweating is often profuse and the moist clammy palm of those patients is typical. Later the degree of nervous instability increases and they suffer from alternate fits of great excitability and depression In the more severe cases either acute mania or melancholia precedes a fatal issue.

2 Cardiac One of the earliest symptoms is a feeling of palpitation with a rapid pulse rate due to toxic myocardial degeneration As time goes on the heart dilates and auricular fibrillation occurs Many patients are diagnosed as having valvular disease or paroxysmal tachycardia without any thought being given to an underlying thyrotoxicosis An important lesson emerges, viz. in every case of disordered action of the heart which presents no previous history of illness likely to affect the heart and having no clearly defined cause the possibility of thyrotoxicosis must always be considered

3 Alimentary Vomiting and diarrhoea are usually seen only in the later stages or in fulminating cases Glycosuria is also a late symptom They should be regarded as indications that treatment is urgently needed if the patient is to be saved.

C Ophthalmic.—Protrusion of the eyes from which the disease takes one of its names is an early and characteristic feature (Fig 194) It is frequently the reason for which a patient seeks advice



Fig. 194

A very typical appearance in exophthalmic goitre, the long thin neck, the moderate enlargement of the gland and the staring eyes.

D General.—(1) Loss of weight is universal and its arrest and subsequent gain is the most important indication of response to treatment (2) Women usually suffer from a disturbance of menstruation, varying from complete amenorrhoea to irregular periods (3) The B.M.R. is always raised and affords a guide to the degree of toxicity Its importance must not be exaggerated and should be considered only in association with weight and response to medical treatment in assessing prognosis and the need for surgical intervention

Signs—*A* Thyroid Enlargement—The slight or moderate enlargement affects the whole gland but not necessarily equally It is smooth firm and regular In the later stages or after iodine medication the gland becomes much harder

B Muscular Tremor is constantly found. It is demonstrated

by asking patients to hold out their hands with fingers separated. A fine tremor of the tongue can also be elicited in many cases.

C TACHYCARDIA is present in every patient even in the early stages When taken in conjunction with loss or gain in weight it forms a most valuable gauge of the degree of toxicity Owing to its susceptibility to emotional influences so prominent a feature of this disease the pulse-rate during sleep is more reliable than at other times It may rise to 180 beats per minute in severe types, 120 to 140 in cases of moderate severity and 100 in mild forms During auricular fibrillation much irregularity in the pulse may be expected

D EXOPHTHALMOS is by no means constant It may be absent throughout, occur either early or late be slight or marked and affords no guide to the severity of the toxicosis Its cause is unknown one theory postulates that it is due to overaction of Müller's unstriped muscle at the back of the eyeball Doubt is thrown upon the very existence of this muscle if present it could not push the eye forward. Overaction of the sympathetic is suggested as an explanation, but resection of the cervical sympathetic produces little or no improvement in the proptosis In some cases there is an increase in retro-ocular fat, but it is doubtful if this is the real cause of the exophthalmos

Exophthalmos is important for two reasons First when severe it may threaten the integrity of the eye because of corneal ulceration and panophthalmitis Secondly it may be permanent if operation upon the thyroid is delayed too long

E OCULAR SIGNS—1 Von Graefe's sign is demonstrated by instructing the patient to keep the head still and look up She is then asked to look down to the floor when the upper lid is seen to lag behind the eyeball and come down in a series of little jerks instead of moving smoothly and simultaneously with the globe

2 Moebius sign is the inability of the eyes to converge on near accommodation

3 Stellwag's sign consists in widening of the palpebral fissure with imperfect closure of the lids.

4 Dalrymple's sign is a rather fixed stare due to retraction of the upper lid, even when exophthalmos is absent

5 Joffroy's sign is the absence of wrinkling of the forehead when the patient looks up This is not constant

Treatment falls into three groups.

A MEDICAL.—*Rest* in bed is an essential preliminary to other forms of treatment It leads to a fall in pulse-rate and B.M.R and to an increase in weight. The time thus spent depends entirely upon the progress of each individual

Iodine Medication.—Iodine is administered in the form of Lugol's mixture, which is a 5 per cent solution of iodine in a 10 per cent aqueous dilution of potassium iodide It is given in 5-minim doses three times a day and the dose increased daily up to 10 minims thrice daily Its effect is rapid and striking the pulse-rate falls the general condition improves and the B.M.R. drops Its maximum effect is reached between the tenth and twenty-first day Its continued use beyond the fourth week leads to an increase in the size of the vesicles,

which become packed tight with colloid and the gland is much harder as a result. Such misuse may produce a return of symptoms more severe than before. Iodine is therefore IN NO SENSE CURATIVE and there is an ideal time for its use A second course at a later date is not usually so effective.

Of recent years treatment with a new drug called Thiouracil" has been given an extensive trial. The results have shown considerable variation from different observers In early and mild cases there are grounds for the belief that the thyrotoxicosis may be improved or even completely arrested, but in the more advanced stages thiouracil is of doubtful value Moreover it is not without the danger of producing untoward effects upon the white blood corpuscles

B RADIOLOGICAL.—Improvement follows X-ray therapy in many cases but it is not curative except in a few patients and relapses are to be expected. It has definite indications as will be seen later

C SURGICAL.—Subtotal thyroidectomy in which seven-eighths of the gland is removed, is the method of choice

In preparation the patient is kept in bed on a light diet with plenty of fluids In moderate cases the operation is fixed for the twelfth day following the beginning of iodine treatment which is continued for ten days after operation. In the severe cases the iodine is withheld until such time as the patient has improved to a point at which it can confidently be expected to achieve its maximum effect and bring the patient within the limits of operative safety Anæsthesia may be avertin and gas-oxygen-ether local infiltration of the skin together with cervical plexus block or by simple straightforward inhalation. Technique is directed towards adequate access gentleness of handling and removal of seven-eighths of the gland, the parts left being the posterior area of the capsule and a thin slice of each lateral lobe This ensures an adequate residue of thyroid tissue preserves the parathyroids and prevents injury to either recurrent laryngeal nerve Great care is taken in accurate suturing of both platysma and skin, the wound being drained for twenty four hours

Application of Alternative Methods—Every patient must be judged upon the individual clinical picture In few other diseases is the decision as to when to operate and the pre-operative preparation so important In every case a routine examination will search for focal sepsis or intercurrent disease and appropriate therapy be directed to each It is advantageous to discuss treatment by dividing patients into three groups

1 Mild group These patients have mild symptoms a pulse-rate not above 100 a B.M.R. not exceeding +25 and no great loss of weight They should be put to bed and any underlying psychological cause sought for and treated. X ray therapy is of value but iodine must not be given. If marked improvement is not evident within six to eight weeks, operation should be advised.

2. Moderate group into which the majority fall is the ideal surgical one and no time should be lost in preparing for operation.

3 Severe group Patients are too ill for operation and every effort must be made to prepare them for it as quickly as possible

A The thyro-adenoma malignum in which the *primary nodule cannot be* detected and yet widespread bony metastases occur in which the tissue appears microscopically to be and can function as normal thyroid. A specialised, but very rare type of carcinoma occurs in young people usually males, during adolescence It does not appear to be highly malignant but repeated local recurrence is usual unless the whole gland is removed.

If the carcinoma starts in a pre-existing goitre there is a sudden increase in its size On the other hand, there may be enlargement of a previously normal gland. The swelling is very hard irregular and nodular and rigidly fixed to *surrounding structures* *Hoarseness* comes on when the recurrent nerves are affected and stridor and dyspnoea result from tracheal compression Later the growth ulcerates through the trachea and a profuse blood-stained sputum appears As the growth spreads along the trachea, respiratory obstruction becomes most distressing, and is marked by violent attacks of coughing Pain is a variable symptom. Death occurs from suffocation broncho-pneumonia or secondary hæmorrhage

Treatment by radical thyroidectomy is rarely possible owing to the extent of the growth when first seen Threatened suffocation may *demand a tracheotomy* but *this inevitably means the beginning of* the end from broncho-pneumonia. Many conflicting opinions are heard concerning radiotherapy X rays appear to be useless but some improvement can be expected from the implantation of radium or radon seeds and by the administration of radio-active iodine

OPERATIONS UPON THE THYROID GLAND

Partial Thyroidectomy—The patient is placed upon the operating table with a small rubber pillow beneath the shoulders so that the neck is fully extended Many surgeons follow Dunhill's technique in infiltrating with 1/100 000 adrenalin the skin and subcutaneous tissues within an area bounded by the clavicles below the thyroid cartilage above and well back beyond the anterior border of sternomastoid muscles on either side This not only *reduces hæmorrhage but greatly facilitates raising of* the skin flaps and saves time

A slightly curved incision is made in a skin crease two finger breadths above the clavicles. The line of this incision should be cross-marked with gentian violet or light needle scratch to assure accurate *apposition later* The cut is deepened through the platysma and the upper skin flap reflected as far as the upper margin of the thyroid cartilage the lower flap is raised sufficiently to display the suprasternal notch and upper border of each clavicle

The superficial layer of the deep cervical fascia is incised in the midline from the upper border of the thyroid cartilage to the suprasternal notch. The infrahyoid muscles of each side are separated and the dissection carried down to the thyroid gland. It is an essential step at this point to define the exact line of cleavage into which the right index finger is slipped By gentle digital dissection these muscles are separated from the gland and a retractor *inserted* to hold them firmly aside It is rarely necessary to divide them. It is immaterial which side is dealt with first Careful dissection by a Kocher's dissector defines the middle thyroid vein which is underrun with an aneurysm

needle tied in two places and divided The next step is the freeing of the upper pole The finger is swept gently upwards, its tip travelling along the posterior margin of this pole which is thus mobilised The antero medial border is now dissected free from the thyroid ala when the vascular pedicle containing the superior thyroid artery and vein is readily defined These vessels are firmly ligated and divided Further dissection carries the mobilisation of the upper pole down towards the isthmus

The surgeon now turns his attention to the lateral lobe and lower pole his technique must now be planned to leave sufficient thyroid tissue for the body s needs. This is done by leaving undisturbed a thin slice of the posterior aspect of this part of the gland on each side By so doing three important objects are achieved (1) preservation of thyroid function (2) protection of the recurrent laryngeal nerve and (3) non interference with the parathyroid glands A row of artery forceps is placed along the lateral margin at such a level as will leave the required thickness of gland behind these forceps bite into the gland which is then divided anterior to them This process is repeated until the dissection reaches the trachea when the main bulk of one side of the gland will be freely mobilised but still attached to the isthmus All vessels are now ligated, care being taken to obtain hæmostasis in the cut thyroid surface Dry gauze swabs are gently packed into the cavity and the retractor removed

An exactly similar procedure is now carried out on the other side Eventually the main mass of the gland on each side is free except for its attachment to the isthmus. This is now freed from the trachea and the removal is at an end The second side is now packed with dry gauze while the first is carefully inspected after removal of the swabs It should be quite dry finally the opposite side is again examined.

The space must be drained for thirty-six hours Dunhill does so by bringing a wick of rubber tissue out at each end of the incision, while other surgeons make a small stab in the skin of the suprasternal notch and introduce a small split tube. The deep cervical fascia is now sutured and finally the wound is closed First the platysma is meticulously stitched and the skin approximated with the finest silkworm-gut

Removal of Localised Swellings.—The approach is identical as for more radical measures. An encapsuled adenoma may be removed by one of two methods, either by enucleating it cleanly from its bed or by a resection enucleation, taking a thin slice of thyroid tissue with it

R. M. HANDFIELD-JONES

CHAPTER XX

THE EAR

SURGICAL ANATOMY —The auricle has a framework of cartilage covered by a thin layer of skin. In suturing wounds of the auricle the stitches should not be passed through the cartilage but should include only the skin so that a line of sutures on the front and back may be necessary The lobule containing no cartilage is more pliable

The external auditory meatus partly cartilaginous and partly osseous, is lined with skin and closed at the inner end by the tympanic membrane *The outer cartilaginous meatus* is about a centimetre in length The osseous meatus about twice as long terminates in a ridge which has a groove on its free border for the attachment of the tympanic membrane (Fig 196) In the upper part there is a hiatus in the ridge the notch of Rivini, the edge of which gives attachment to Shrapnell's membrane To straighten the *meatus for examination or syringing* the auricle should be drawn backwards and upwards. In early life the annulus tympanicus is near the surface and there is no osseous meatus, which lengthens the meatus as it develops. Consequently in small children the tympanic membrane is very near the opening of the external auditory meatus and the auricle need only be drawn backwards for examination of the membrane The skin of the cartilaginous meatus contains sebaceous and ceruminous glands, which latter are modified sweat glands.

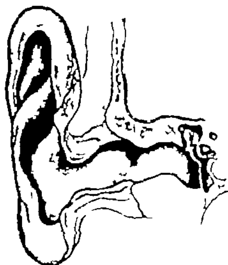


FIG. 196

A cross-section of the outer and middle ear showing the tympanic membrane and the ossicles.

The tympanic membrane lies at an angle of 55 with the horizontal plane Its outermost part is above and behind and its innermost below and in front. It is composed of three layers an outer epithelial layer continuous with the skin, an inner one continuous with the mucous lining of the tympanum and a middle fibrous layer composed of circular and radiating fibres. In this way the membrana tensa is formed The fibrous layer is absent in the portion which occupies the notch of Rivini and thus the *membrana flaccida* or Shrapnell's membrane is formed The long process or manubrium of the malleus lies in the tympanic membrane and passes upwards and forwards. Its tip is fixed to the membrane at the umbo and above its short process the malleus is not so attached. The

important landmarks on inspection with mirror and speculum are the manubrium with the cone of light spreading downwards and forwards from its tip at the umbo to the margin the short process with a fold stretching backwards and forwards to either extremity of the notch of Rivini and Shrapnell's membrane above these folds If the membrane is thin the long process of the incus may be visible behind the handle of the malleus

The outer wall of the tympanum consists mainly of the tympanic membrane (Fig 198) but above that is an overhanging portion of the squamous portion of the temporal bone In this way the attic which contains the head of the malleus and the body of the incus is formed It is to a great extent shut off from the lower part of the tympanum and lies above the level of a line joining the two tympanic spines which bound the notch of Rivini The attic communicates posteriorly with the mastoid antrum by the *aditus ad antrum* The horizontal semicircular canal forms a slight prominence on the inner and lower walls of the aditus The facial nerve after passing back wards in the aqueductus Fallopii on the inner wall of the middle ear above the oval window turns downwards and outwards to the stylomastoid foramen. It is therefore below and in front of the mastoid antrum In the infant the mastoid process has not developed, so that the antrum lies higher above rather than behind the middle ear and the facial nerve escapes from the stylomastoid foramen beneath the skin unprotected by the mastoid process The nerve may then be divided by an incision incautiously carried down to the bone.

The external aspect of the mastoid gives no information in regard to its internal structure the depth of the antrum the position of the sigmoid sinus or the level of the middle fossa The suprameatal triangle is a fairly constant guide to the level of the antrum. This is formed by the posterior root of the zygoma above the upper and posterior segment of the osseous meatus below and behind by a vertical line drawn from the most posterior point of the osseous meatus to the zygomatic root

The internal structure of the mastoid process shows considerable variation in the degree to which the air cells are developed When the air cells are fully developed as in about 40 per cent of skulls, the mastoid is termed "pneumatic" In 20 per cent the bone marrow spaces have not been pneumatised and to this type the term "diploetic" is applied. The remainder are partly pneumatic and diploetic or are composed of ivory hard bone the latter forming the sclerotic type It is possible that inflammatory changes occurring early in life interfere with the process of pneumatisation. When fully developed the pneumatic cells are found in the following *groups* —

1 Zygomatic The cells of Kirschner in the posterior root of the zygoma
2. Retrofacial Cells on the posterior meatal wall running along the aqueduct They may extend behind the horizontal canal into the petrous beneath the labyrinth and also beneath the middle ear as peribulbar cells in close relation to the jugular bulb
3 Apical cells. There is often one large cell near the tip of the mastoid process
4 Marginal cells. These are in the posterior part of the mastoid process lying around and behind the lateral sinus from which they are separated by a plate of dense bone The mastoid emissary vein runs through them and they extend upwards into a group of cells lying between the lateral sinus and the dura of the middle fossa
5 Central cells. These occupy the middle portion of the process.

All these groups of cells must be followed out in the operation for acute suppuration in the mastoid process (p. 406)

The extent to which the lateral sinus cuts into the inner surface of the mastoid process and approaches the posterior wall of the osseous meatus is also very variable It may lie as much as an inch behind the meatus, while at other times it lies so close behind that the exposure of the antrum is extremely difficult, and this has to be approached by working backwards from the attic The middle fossa may be low and overhang the outer side of the antrum and this anatomical formation is commonly associated with a forward lying sinus, thus limiting the field of operation still further

The deep cervical fascia is attached to the mastoid process, so that if pus perforates the inner plate of the mastoid process it may track deeply along the posterior belly of the digastric or down the neck (Bezold s mastoiditis)

Examination of the Ear—I. Otoscopy—The symptoms of which complaint may be made are deafness, tinnitus pain, vertigo and discharge but before any further investigation of these is made, the ear should be inspected and wax pus or debris removed for until this is done any other examination is futile. The fluid for syringing should be comfortably warm and the patient must always be sitting lest vertigo be induced. The meatus is dried with cotton wool held in angular forceps and then inspected. Unusual and misleading appearances are frequently due to failure to cleanse the meatus before examining with mirror and speculum. Several sizes of speculum should be available The light is reflected on the auricle and any external abnormality noted. The speculum held by the forefinger and thumb of the left hand is warmed and inserted into the meatus which is straightened by drawing the auricle upwards and backwards with middle and ring fingers. The condition of the meatus, the colour of the membrane, the presence of the light reflex, the inclination of the malleus, the prominence of its short process and of the anterior and posterior folds, the presence of perforations, patches of calcification or of pulsation in any part are points to be noted Swelling or exostoses of the meatus may prevent a satisfactory view from being obtained. A magnified image is obtained by using Siegle's speculum which enables the air pressure in the meatus to be varied. Thus mobility of the membrane and ossicles may be tested and the position of an otherwise invisible perforation be detected (Fig 197)

If compression of air in the Siegle s speculum produces nystagmus in the presence of a perforation, a fistula of the external canal, transmitting increased pressure to the labyrinth, may be present, but cannot be diagnosed with absolute certainty

II. Testing the Hearing —Qualitative Tests —These are used to determine whether diminished hearing is due to (1) causes lying in the auditory canal or the middle ear (conductive deafness) or (2) causes in the labyrinth or auditory nerve or its central connections (perceptive deafness) These tests depend upon the conduction of sound vibrations through the skull bones to the cochlea (bone conduction) being unimpaired in affections of the middle ear and auditory meatus but reduced or destroyed in affections of the auditory end organ and its connections

1 *Schwabach s Test*—The base of a tuning fork (256 C P.S) is applied to the mastoid process and if the time of hearing is shortened as compared with the capacity of the examiner (diminished bone conduction) the deafness is of the perception type If the hearing time is prolonged then the deafness is of the conduction type

Absolute bone conduction of the patient and examiner can be compared by performing this test with the auditory meatus closed so as to exclude

sounds which might mask the hearing by bone conduction No pathological condition produces an increase of bone conduction beyond the absolute degree

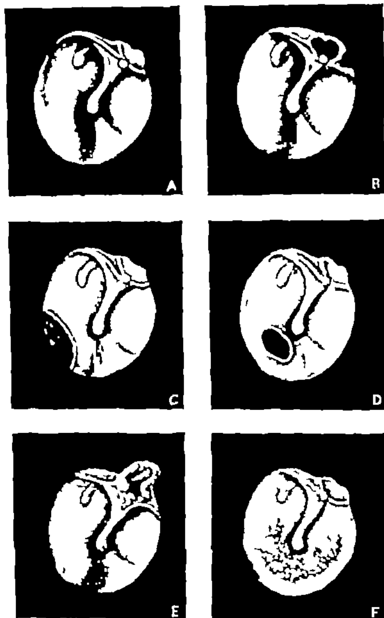


FIG 197

The various appearances of the tympanic membrane as seen through an aural speculum. A, normal; B and E, attic perforations; C, a marginal and D central perforation; and F calcareous thickening of the membrane.

thus determined although it may appear to be relatively increased with the meatus open

2 *Weber's Test* —This is used in cases of monaural deafness The base of the fork is applied to the middle of the forehead and is heard better in the

deaf ear in conductive deafness and better in the good ear in perceptive deafness.

3 *Rinne's Test*.—This depends upon comparison between the capacity for hearing the fork by air conduction when the prongs are held close to the auditory meatus and by bone conduction when the base is placed on the mastoid process of the same ear. *If air conduction exceeds bone conduction* the test is positive. This occurs normally and in perceptive deafness. Bone conduction exceeds air conduction (negative Rinne's test) in conductive deafness.

When testing an ear completely deafened by a perceptive type of deafness, a "false" negative result will be produced owing to the sound being conveyed to the opposite cochlea (normal) by bone conduction. Application of the Weber test will usually detect this seeming anomaly.

QUANTITATIVE TESTS.—1. *Testing with the Voice*.—Because the voice is the most important sound to be appreciated in ordinary life it forms a ready standard for testing, provided care is taken to maintain it at a constant level in a quiet room. The distance at which the whispered and conversational voice can be heard is used as a measurement of auditory acuity.

2. *Audiometry*.—The audiometer is a valve oscillator which produces through a headphone pure tones of which the frequency and intensity can be controlled by the examiner. The intensity measured in decibels[1] at which each selected frequency is just heard by each ear is recorded on a chart (audiogram). Generally it is found that in diseases of the middle ear the lower part of the scale is affected, whilst in affections of the cochlea the higher notes are lost. Recently speech audiometry has been developed. Here standard gramophone records of selected words or syllables are played and their intensity is attenuated as in pure tone audiometry.

III. Testing the Patency of the Eustachian Tube.—The condition of the Eustachian tube, which may be obstructed or contain mucus, is investigated by inflation. The mouth is shut, the nostrils closed by the thumb and first finger and a forcible attempt made at expiration (Valsalva's experiment). Politzer's method is better. The patient takes a sip of water and holds it in the mouth. The nozzle of a Politzer's bag is inserted into one nostril and then both are closed so that no air can escape. The patient is told to swallow and at the moment of swallowing the bag is compressed and the air is driven up into the tympanum. The mouth must be kept tightly closed during the act of swallowing. It is generally believed that the orifice of the Eustachian tube is opened during swallowing by contractions of the tensor palati.

A more certain way of inflating the tympanum is by the Eustachian catheter. This has a curved beak to fit into the orifice of the tube and near the proximal end is a ring whose plane coincides with that of the beak and so indicates its position when concealed. Before passing the catheter through the nose some 5 per cent. cocaine may be applied if there is a sensitive spur low down on the nasal septum, but the application is not necessary as a routine. The catheter is introduced along the floor of the nose until it reaches the posterior pharyngeal wall. The point is turned outwards into the fossa of Rosenmuller, and as it is gently withdrawn it slips over the posterior lip into the mouth of the tube. It is generally possible with practice to turn the tip of the catheter into the tube as soon as the soft palate has been passed. A bag is then attached to the catheter and air blown gently into the Eustachian tube. An auscultation tube connecting the ear of the patient and the surgeon will indicate by the sound, which normally is of a dry blowing character, whether air is passing into the tympanum as a result of any of these methods of inflation. Bubbling sounds indicate catarrh, and if there is a perforation of

[1] A decibel is the smallest difference in intensity of sound appreciated by the normal ear.

the tympanic membrane a whistling sound is heard close to the ear of the observer Sometimes the tympanic membrane can be observed to bulge outwards during the Valsalva experiment The hearing should be tested before and after inflation

IV Tests for Labyrinthine Activity —The functional activity of the vestibular portion of the labyrinth can be tested by caloric and rotation tests By irrigating the ear first with water heated to 44 C and afterwards with water cooled to 30 C., that is at temperatures equidistant above and below blood temperature convection currents are set up in the membranous labyrinth and nystagmus produced By observing the duration of the nystagmus produced by these four irrigations an indication of the functional activity of the semicircular canal system in each ear can be deduced Tests involving the rotation of the patient with the head in varying positions will produce nystagmus of varying character and duration Rotation affects both ears simultaneou ly but in opposite directions Just as compensation makes the investigation of defective cerebral function difficult so it introduces great difficulty into the interpretation of these tests however carefully performed

DISEASES OF EXTERNAL EAR

The pinna is subject to the diseases which affect the skin in other parts. Thus eczema as mentioned, is common and should be treated as it would be elsewhere It may be associated with a chronic discharge from the middle ear in which case treatment must include measures to arrest this chronic otorrhœa Tumours which affect the skin elsewhere also affect the skin of the ear so that sebaceous cysts rodent ulcer and carcinoma may be encountered. Hæmatoma auris an effusion of blood between the cartilage and perichondrium producing a purple swelling of the auricle is generally the result of injury but may be spontaneous in the aged. The hæmatoma does not usually suppurate but in some cases thickening of the auricle may result (cauliflower ear)

INCREASED SECRETION OF CERUMEN

Wax in the external auditory meatus may be secreted rapidly so that a collection is formed. The precise mechanism by which the amount normally secreted is removed from the meatus is not known



FIG. 198

An aural syringe. (*Meyer & Phelps.*)

with certainty Probably the movements of the jaw cause it to be gradually expelled If it collects into a plug causing deafness or reflex symptoms, such as cough it should be removed by syringing with warm water (Fig 198) If the wax is too hard for this it may be first

softened by instilling olive oil or a strong solution of bicarbonate of soda. The introduction of water into the ear often determines the sudden onset of deafness from this cause by causing the cerumen to swell and produce complete obstruction

FURUNCULOSIS

Furunculosis is common in the external auditory meatus and is due to an infection of the ceruminous and sebaceous glands usually by staphylococci It may be associated with boils elsewhere but more often this is not the case Rarely it may be the first indication of diabetes Pain is very severe on account of the unyielding texture of the tissues, and the ear is tender on manipulation. The swelling of the meatus may cause obstructive deafness. If the boil is situated on the posterior wall, swelling behind the ear will simulate periostitis of the mastoid process, but the groove behind the auricle is obliterated by a furuncle in this position *Diagnosis* is occasionally extremely difficult and a radiograph of the mastoid process may prove very helpful A fistula from the mastoid process opening on the posterior meatal wall occasionally simulates a furuncle if there are granulations at the orifice In rare cases the pus from a furuncle may reach the tympanum through the notch of Rivini and cause otitis media Incision of a furuncle is not usually required. Hot applications and gentle cleansing may be all that is required but as the organisms are usually sensitive to penicillin systemic treatment with this antibiotic offers the most dependable method of treatment The pain is sometimes so great that morphia is needed

EXTERNAL OTITIS

This troublesome clinical condition may be associated with several different causes. Frequently there is an underlying allergic factor producing an eczema which becomes secondarily invaded by staphylococci and other organisms. Sometimes the condition is dependent upon the presence of a seborrhoeic dermatitis often in the scalp Some cases of external otitis are the result of scratching the ear with a dirty finger nail. In hot and humid climates otitis externa may assume almost epidemic proportions When a membrane resembling damp blotting paper covered with black or yellow spots is seen in the meatus, associated with itching and discharge otomycosis should be suspected. This is caused by *Aspergillus niger* or *A flavus* The spores of these fungi are probably secondary invaders upon a chronic dermatitis of the canal Successful treatment depends upon scrupulous and regular cleansing of the ear after irrigation with a dilute lotion of liquor picis carb and after this calamine lotion may be applied and allowed to dry Local application of penicillin is often disappointing and where allergy is a factor reactions to this and to the sulphonamides are not uncommon *The scalp must be frequently shampooed when it is seborrhoeic*

OSTEOMA OF THE MEATUS

This may take the form of either exostosis or a diffuse hyperostosis Extostoses are frequently multiple and sometimes symmetrical in both ears Virchow attributed their origin to some abnormality of development in the annulus tympanicus Frequent sea bathing has also been suggested as a possible cause Exostoses may cause obstructive deafness, and less commonly tinnitus and vertigo They should not be removed unless causing symptoms If pedunculated they can be easily removed through the meatus with mallet and chisel If sessile great care must be taken to avoid damage to the tympanic membrane an electric burr used via the endaural approach (p 406) being the method of choice When a chronic discharge from the tympanum is associated with exostoses they are a source of danger as they obstruct the drainage from an area of caries and in this case the radical mastoid operation is indicated to remove them and cure the discharge from the middle ear

INJURIES AND FOREIGN BODIES

Injuries to the external auditory meatus may be caused by foreign bodies and are still more likely to result from attempts at removal. A foreign body of itself causes little damage and may be left alone temporarily unless it is touching the tympanic membrane when severe pain will be produced On the other hand if a smooth round object is seized with forceps it is more likely to slip further in than to be held firmly and the instrument will probably injure the walls of the meatus The meatus should be examined with a speculum and, if a chink is present between the foreign body and the meatal wall, a hook may be passed through and the foreign body drawn out or a jet of warm water directed into the chink with a powerful syringe will wash the foreign body out of the ear If there is no space to allow either of these manœuvres it is necessary to turn the auricle forwards and extract the foreign body through an incision in the posterior meatal wall The irritation of an aural discharge sometimes explains why a child introduces the foreign body The foreign body may then obstruct drainage and cause severe symptoms Injuries may also be caused by indirect violence especially by a blow or an explosion. In such cases the tympanic membrane is likely to suffer a linear split which becomes an oval or round perforation The edges bleed, but if the ear is kept dry and all syringing avoided healing usually takes place without suppuration. If an explosion such as the bursting of a shell, ruptures the membrane the edges are usually found to be everted, and almost the entire membrane may be blown out in this way The bleeding may be profuse and the temptation to syringe out the ear must be resisted. Rupture of the membrane seems to protect the labyrinth but if the explosion does not rupture the membrane and only produces some punctate hæmorrhages the labyrinth may be concussed and a high degree of internal ear deafness may follow Recovery is more likely from deafness produced thus than from the deafness caused by long exposure to the sound of gun fire without any visible change in the tympanic membrane

Similarly noisy occupations such as riveting boiler making etc., carry the hazard of permanent high tone deafness (acoustic trauma) Workers in these trades should be protected with ear plugs.

DISEASES OF MIDDLE EAR

ACUTE OTITIS MEDIA

Acute otitis media is often preceded merely by an ordinary sore throat or nasal catarrh but a common cause is an attack of influenza. The exanthems are also an important cause especially scarlet fever measles and diphtheria. It occurs occasionally during the course of typhoid fever The pathogenic organisms are usually either the hæmolytic streptococcus pyogenes which is the infective organism in scarlet fever the *S viridans* or the pneumococcus The pneumococcus mucosus (Type III pneumococcus) is especially dangerous for although at first the symptoms are mild it may cause meningitis. *S aureus* is occasionally found in pure culture. Other organisms are rare *S pyogenes* is the most important on account of the bone destruction and liability to intracranial complications associated with it The wide *straight Eustachian tube of infants favours the occurrence of otitis* media and in children the presence of adenoids is a common predisposing cause It is also liable to occur as a complication after operation on the nose or nasopharynx Diabetics are liable to it as to other forms of suppuration

In the early stage there is hyperæmia of the mucous membrane followed by a serous exudation often accompanied in influenzal cases by small hæmorrhages The exudate soon becomes purulent and the tympanum contains at first serum then mucus or mucopus The inflammation may be limited to the tympanum but it usually extends to the mastoid antrum and all the spaces connected with the middle ear

Clinical Picture—Pain and deafness are the most prominent symptoms Tinnitus of a pulsating character may be present though it is not distressing The pain is often severe worse at night and radiates over the side of the head and down the neck There may be some tenderness over the mastoid process The pain is sometimes quite slight especially in scarlet fever and diphtheria On examination at *an early stage the tympanic membrane is seen to be flushed* and shows a network of dilated vessels but the outline of the malleus is still visible In a few hours the membrane is seen to be bulging and bright red in the posterosuperior quadrant A little later its whole surface is uniformly red and bulging so that all the normal landmarks, including the malleus are obscured In influenza there are often blebs on the surface of the membrane containing blood-stained serum If the membrane is not incised, a yellow spot appears most commonly in the posterior quadrant where rupture takes place and pus is discharged into the meatus The inflammation may be limited to Shrapnell's membrane and resolution begin at any stage before rupture occurs The pain is usually relieved instantly by rupture or *incision of the membrane* but this is not invariable and persistence

of pain does not necessarily indicate retention of pus in the mastoid process although it is a suspicious symptom In infants in whom the membrane is thick it may be bulging but dull white or grey and not red as in older patients At the onset there is usually but not invariably a rise of temperature most pronounced in children, in whom it may reach 103° or 104 F

Treatment —As almost all the organisms likely to be met with are sensitive to penicillin this agent constitutes the main line of treatment Sulphonamides by the oral route may be more convenient especially in children and are often sufficient Administration with penicillin and/or sulphonamides should be started as soon as possible and the blood concentration of the drug maintained to its therapeutic level until and beyond the subsidence of all clinical symptoms If the membrane is bulging and great pain is present or if antibiotics and chemotherapy have failed to improve the condition rapidly the membrane should be incised through its most prominent part This is accomplished with a sharp myringotome and the incision usually in the posterior half is a vertical one carried down to the inferior margin A short general anæsthesia is required for children but if the myringotome is really sharp anæsthesia may often be dispensed with in adults. After incision a gauze wick in the meatus will assist drainage and the ear should be covered with a dressing The wick should be renewed frequently If the discharge is very profuse the meatus may be irrigated with a dilute solution of biniodide of mercury several times a day In the majority of cases resolution follows with healing of the perforation and restoration of hearing Politzerisation is often necessary to restore the hearing fully In a few cases intratympanic adhesions especially around the stapes may cause permanent deafness.

In spite of systemic disinfection and incision of the membrane or a spontaneous rupture the febrile symptoms may persist and the discharge continue undiminished or only slightly diminished in quantity Such symptoms especially if accompanied by persistent bulging in the posterosuperior quadrant of the membrane and tenderness at the tip of the mastoid indicate retention of pus in the mastoid process The mastoid antrum and cells should then be opened by the simple mastoid operation without waiting for swelling or periostitis of the mastoid process to appear In this way the tympanum is freed from the pus reaching it from the mastoid process, the hearing saved, and at the same time the patient is placed in comparative safety The administration of penicillin and sulphonamides may at times reduce the intensity of the infection without effecting a complete cure some residual deafness perhaps being the only symptom left In such cases there may be a masked mastoiditis which may reveal itself by the onset of some dangerous intracranial complication even after the patient has been discharged from hospital. This possibility calls for the greatest caution in the observance of such cases and it is safer to resort to surgery when in doubt

Complications —During an attack of acute otitis media the patient must be watched for the signs of mastoiditis as mentioned above and also for any signs of irritation of the labyrinth or infection of the great

venous sinuses. Meningitis, cerebral or cerebellar abscess may occur but they are rare complications of acute otitis Collections of pus may form between the roof of the antrum and the dura mater or more commonly around the lateral sinus. These extradural abscesses are frequently discovered during the course of a mastoid operation

A rare situation for extradural abscess is at the apex of the petrous. In addition to general symptoms, such an abscess is liable to cause paralysis of the VIth nerve shown by an external rectus palsy and neuralgia in the first or first and second divisions of the Vth nerve (syndrome of Gradenigo) *The prognosis of an abscess in this situation* is grave but the symptoms may be produced by a serous effusion, in which case the patient can recover without operation A leucocyte count is a useful aid in distinguishing between the two conditions. Penicillin has greatly improved the *prognosis of this disease*

NON SUPPURATIVE OTITIS MEDIA

Deafness.—A conductive deafness is commonly the result of a chronic exudative catarrh of the middle ear It can often be relieved by treatment with the Eustachian catheter but sometimes the middle ear contains fluid which has to be evacuated by myringotomy or by suction through the tympanic membrane by means of an aspirating needle and syringe The serous fluid may show as a horizontal line across the drum or bubbles may be distinguished in it—this kind is often sterile Occasionally permanent deafness results from secondary adhesive processes

CHRONIC SUPPURATION OF THE MIDDLE EAR

The majority of cases of chronic infection follow an attack of untreated acute suppuration which has never resolved. A few however arise insidiously and are tubercular in nature and in some others a small perforation is situated in Shrapnell's membrane above the short process of the malleus In these there is no history of acute otitis, but the membrane atrophies and finally breaks down with chronic attic suppuration as a secondary result

Deafness and discharge from the ear are the only symptoms in the majority of cases which explains the neglect of the aural condition, but headache and attacks of pain both in the ear itself and in the temporal region are common symptoms demanding relief Examination after cleansing the meatus shows in every case a perforation which is usually central so that its edge does not reach the marginal attachment to the tympanic ring Such a perforation may be small or large circular oval or crescentic and there may be adhesions between its edge and the inner wall of the tympanum. Unless this condition, which would obstruct drainage is present such central perforations are innocuous and are not associated with caries of the middle ear but only with a mucopurulent catarrh of the tympanic mucous membrane.

Marginal perforations in which part of the circumference is formed by the bone at the periphery of the membrane (Fig 197 E) may indicate caries of the adjacent bone and of the ossicles. Many are

situated either in Shrapnell's membrane or the posterosuperior quadrant of the membrana tensa or sometimes in both and thus lead directly into the attic aditus and antrum Proliferation of the flattened type of epithelium lining the attic leads to the exfoliation of successive layers to form a compact mass of squamous cells which is capable of reaching a large size and eroding the bone deeply In this way a cholesteatoma is formed Cholesterin crystals are found in it and it may be permeated by pus.

Granulations bathed in pus may be seen attached to the underlying carious bone and protruding through the perforation They may reach a large size become covered with squamous epithelium and fibrous in structure An aural polypus thus formed often fills the meatus and resembles a fibroma The attachment is usually to a carious area of the tympanic ring but it may be to an ossicle to the promontory or even to the edge of the perforation in the tympanic membrane For this reason after simple removal, an aural polypus almost always recurs from the same underlying area of caries

In cases of central perforation the ear should be kept clean by syringing drying and then insufflating boric acid powder containing 2 per cent of iodine This will usually render the ear dry and sometimes the perforation may heal It is a dangerous condition only if the edge of the perforation is adherent to the inner wall of the tympanum

Marginal perforations, accompanied by a foul discharge and cholesteatoma are indications for the radical mastoid operation or some modification of it designed to conserve hearing as much as possible

TUBERCULOSIS OF THE EAR

Primary tuberculosis of the ear occurs in infants and young children from infection by milk via the Eustachian tube which may itself be affected. A blood borne infection is also possible When facial palsy and enlargement of the cervical glands accompany the otitis the diagnosis is almost certain from clinical observation only but it may easily be missed unless the aural discharge is examined for the presence of tubercle bacilli. A mixed infection soon supervenes

In a few phthisical patients a tuberculous otitis media develops and must be distinguished from those ordinary forms of middle-ear disease which may and often do attack such patients The onset of this tuberculous lesion is insidious and painless, resembling a mild catarrhal otitis. It may heal but commonly there is a spontaneous perforation of the tympanic membrane Incision is unnecessary as there is no pain and it merely serves to introduce secondary infection The perforation is sometimes multiple and bacilli may be found in abundance in other cases they are so scarce that it may be necessary to inoculate a guinea pig to establish the diagnosis.

SYPHILIS OF THE EAR

Chronic suppuration in the middle ear is occasionally due to syphilis and its true nature is likely to be overlooked owing to its resemblance to the more common forms of otitis media Such patients will not

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Penicillin administered systemically is of great value in treatment and justifies some restriction in the scope of those drastic operations, especially in children, in whom pyæmic abscesses may absorb under its influence without being incised The extension of an aseptic thrombosis from the lateral sinus into the straight sinus or via anastomotic cerebral veins to the longitudinal sinus will produce the condition of otitic hydrocephalus. This is characterised by a high intracranial pressure without localising signs and without signs of suppuration It responds to daily lumbar puncture in two to six weeks if the focus of infection in the mastoid has been dealt with

Otitic Meningitis

Headache vomiting rise of temperature and rapid pulse in the presence of otitis media either acute or chronic should raise the suspicion of meningitis Confirmatory signs are those of Kernig and Brudzinski The former is difficulty in extending the lower limb in the sitting position because of pain the latter is reflex flexion of the lower limbs which are drawn towards the pelvis in response to passive flexion forward of the head upon the neck. This meningitis may vary from irritation with an excess of cerebrospinal fluid to a fully developed septic meningitis in which the fluid contains pus cells and living organisms. Intermediate in severity is aseptic meningitis in which the cerebrospinal fluid is clear or turbid, for it does not become opalescent until it contains 150 to 200 cells per c mm and is free from living organisms

Lumbar puncture should be performed if it is fairly certain that there is no abscess in the brain, in which case withdrawal of even small quantities is highly dangerous causing either sudden death or rupture of the abscess Glucose may be absent or diminished protein is enormously increased but the most important points in both diagnosis and prognosis concern the cell count and the chloride content A cell count above 5 per c.mm is indicative of a commencing meningitis In septic meningitis polymorphonuclear cells predominate an excess of lymphocytes suggests a chronic protective reaction as in brain abscess or tuberculous meningitis The concentration of chlorides in the cerebrospinal fluid is normally above that in the blood but in meningitis the barrier breaks down and the concentrations tend to approximate. A fall of chlorides in the fluid to 680 mg that is 0 68 per cent is a bad prognostic sign. Bacteriological examination should be made both of the aural discharge and the cerebrospinal fluid

Treatment consists in the systemic administration of the sulphonamides and penicillin concurrently in order to establish control of the primary focus in the mastoid and in this way operation may be avoided. In order to short-circuit the blood brain barrier of the choroid plexus to penicillin 10 ml of a solution of this antibiotic in the strength of 1000 units per ml are injected daily into the spinal theca In addition it may be necessary to introduce this solution into the cisterna magna and directly into the lateral ventricles through a burr hole in the skull It may also be perfused into the subarachnoid space over the cerebral

cortex by means of a fine flexible tube passed between the brain surface and the dura after the lateral ventricles have been tapped

Otogenic Intracranial Abscess

Most intracranial abscesses arise as a complication of chronic suppuration in the middle ear and mastoid antrum generally associated with cholesteatoma The usual situations are the temporal lobe and cerebellum about twice as often in the former as the latter Abscesses of otitic origin in other parts of the brain such as the occipital lobe are rare

If infection spreads slowly through the tegmen of the middle ear or antrum the meningeal spaces are sealed off the cerebral tissue becomes inflamed and finally an abscess is formed In this case it may have a stalk connecting it with the primary focus in the ear Such a track is not always present however and the abscess is separated from the tegmen by a layer of macroscopically intact brain tissue In this type suppuration results from breaking down of infected clot in a thrombosed vein A chronic abscess develops a thick protective wall and may become so encysted that it can be shelled out of the brain

The early stage of a brain abscess is an encephalitis but sometimes this may not proceed to pus formation and may resolve On the other hand, it may be so severe as to be fatal before producing abscess or meningitis. The patient is febrile and has signs suggestive of an abscess but the cerebrospinal fluid is clear If this condition of otogenic encephalitis is not recognised and the dura is incised, the swollen brain bulges through the opening but no abscess is discovered.

An abscess in the temporal lobe may rupture into the lateral ventricle but this accident is sometimes prevented by the obliteration of the descending horn by pressure of the abscess Lumbar puncture however may cause such a rupture A cerebellar abscess is likely to compress the brain stem and so cause distension of the ventricles thus producing an internal hydrocephalus above the tentorium and increasing still further the symptoms of compression Pressure below the tentorium causes herniation of the brain stem into the foramen magnum This makes lumbar puncture in cerebellar abscess very dangerous owing to the risk of respiratory failure from sudden alteration in pressure

Cerebral Abscess.—General symptoms are headache giddiness vomiting and slow cerebration. Usually the temperature is subnormal and the pulse slow because the effects of compression outweigh those of septic absorption but this is not necessarily the case and both temperature and pulse may be raised in the early stages Optic neuritis is frequent especially in subtentorial lesions but it has no localising value Lumbar puncture should be avoided for the reasons stated but if a small quantity of cerebrospinal fluid is examined it will be found to have a normal chloride and glucose content with a low or slightly raised cell count due to a localised meningitis If the abscess is leaking into the ventricle or meningeal space the fluid will be turbid.

There may be no localising symptoms but in temporal lobe abscess pressure upwards upon the pyramidal tract may cause a

contralateral weakness of the facial muscles Pressure exerted more directly inwards may cause a contralateral hemiplegia in which the

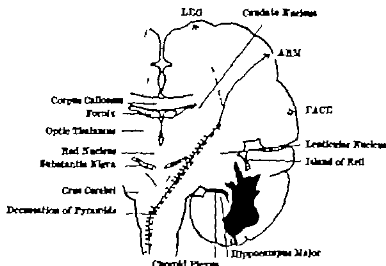


Fig. 199
Cerebral abscess (in black) showing directions of spread and structures likely to be compressed.

lower limb is most affected the fibres to the leg being most exposed to pressure (Fig 199) A fixed dilated pupil on the same side from pressure upon the oculomotor nerve is also *a common sign in this condition.*

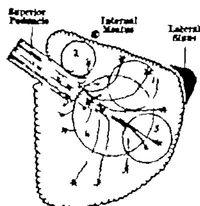


Fig. 200
Sites of cerebellar abscess.
Those in circles 1 and 3 will give no localising signs; those within 2 press upon the peduncle; and those within 4 involve the dentate nucleus, thereby producing symptoms.

In right handed persons abscess in the left temporal lobe might produce *aphasia but this is not common.* It should be tested by asking the patient to name a number of common objects *such as pen pencil or watch* and it may be necessary to use several things, as otherwise a mild degree of aphasia *may escape detection*

Cerebellar Abscess.—In this area there may be no localising signs the reasons for this is explained in Fig 200 If present signs are due to a homolateral loss of postural tone shown by ataxy of the arm and leg on the same side as the lesion There is often nystagmus, but this may be of labyrinthine origin In this latter the coarse movement is to the opposite side and is transient whereas in a cerebellar abscess a similar coarse movement is to the same side and is maintained But a cerebellar and labyrinthine lesion may coexist. In cerebellar abscess the patient may lie on one side in flexion with the eyes deviating towards the sound side or the head may be tilted with

the chin pointing to the sound side and the occiput turned towards the side of the lesion

Treatment —There should be no hurry to operate as long as an abscess is only suspected since non-suppurative encephalitis may subside but immediately the presence of an abscess has been established it must be aspirated without delay the patient being in danger of sudden death from respiratory failure

Whenever possible an abscess should be approached via its stalk. The first step is a radical mastoid operation removing the tegmen tympani et antri freely to expose the middle fossa and the bone internal to the lateral sinus to give access to the posterior fossa. In this way a track leading into either the temporal lobe or the cerebellum will often be found. If the abscess cannot be reached in this way the brain may be exposed through a separate incision This is required more often in cerebellar than in cerebral abscess (see p 807) Repeated aspiration of the abscess and installation of a suitable antibiotic into the abscess cavity is the treatment of choice The addition of thoro trast to the injection gives radiographic evidence of the shrinkage of the abscess.

Otosclerosis

A not uncommon cause of conductive deafness is otosclerosis In this there are no gross changes in the tympanic membrane and there is no improvement in hearing after inflation of the Eustachian tube which is found to be patent Otosclerosis occurs usually in young adults The underlying pathological process is an absorption of bone in the capsule of the labyrinth followed by the deposition of new spongy bone which in its turn becomes compact Discrete deposits may be found in various parts of the labyrinthine capsule but the region of the oval window is the commonest situation As a result of this the foot piece of the stapes becomes fixed by ankylosis in the oval window to produce deafness. Tinnitus is often associated. The pathogenesis is unknown but the disease is aggravated by pregnancy parturition and lactation and as there is a hereditary element in its incidence the question of marriage in sufferers from this disease requires serious consideration Providing the cochlea has not been involved by the disease satisfactory relief may be obtained in many of the patients by the operation of fenestration (see p 407) which consists in making an opening into the perilymph of the semicircular canal which is then sealed by a mobile flap derived from the posterior wall of the auditory canal The formation of a new fenestra when the foot piece of the stapes is immobile makes possible the transmission of a pressure (sound) wave in the cochlea fluids.

Ménière s Disease

The classical symptoms of this disease are attacks of vertigo associated with deafness of the perceptive type and tinnitus the deaf ness usually being unremitting The underlying pathology is distension of the endolymphatic system of the inner ear (endolymphatic hydrops) Cases show great variation in severity some being controlled by

medical treatment consisting of a salt free diet a restricted fluid intake and sedation. Severe cases require destruction of the labyrinth to stop the vertigo either by injection of alcohol transtympanically into the oval window or by opening the external semicircular canal as in the fenestration operation and then extracting all the contained membranous canal.



(a)



(b)



(c)

(Butterworth.)

Fig. 201

(a) Schwartze operation the middle ear remains intact. (b) Radical operation the posterior meatal wall and ossicles removed. (c) Shows the relation of the semicircular canals and facial nerve to the cavity produced by the radical operation.

OTHER FORMS OF INNER EAR DEAFNESS

Permanent deafness results from a non-suppurative effusion into the labyrinth in mumps It may begin with an attack of vomiting vertigo and nystagmus locating the lesion in the labyrinth It is usually unilateral. The deafness caused by cerebrospinal meningitis or congenital syphilis is usually bilateral Acquired syphilis or a tumour of the auditory nerve may give rise to a unilateral perceptive deafness It is possible that a rubella (German measles) contracted during the early months of pregnancy may cause a congenital defect of the cochlear neuroepithelium, besides other defects such as cataract patent ductus arteriosus and microcephaly Toxic deafness and senile deafness are usually bilateral. In all old people the ligamentum spirale atrophies and this is shown first in the lower whorl of the cochlea so as to cause a loss of hearing for high notes.

Operations

The operation for *acute suppuration* in the mastoid process following otitis media, often called *Schwartze's operation* (Fig 201 (a)) aims to preserve the middle ear intact Access to the mastoid process and middle ear cavity may be made either by a postauricular incision made parallel to and just behind the postauricular sulcus or via an endaural approach *The simplest form of the latter consists of a single curved* incision which starts just in front of the anterior extremity of the helix and runs down the posterior meatal wall at the junction of the bony cartilaginous portion When the soft tissues are elevated from the underlying bone and

the lips of the incision spread by a retractor a very direct approach is given through the suprameatal triangle and posterior wall of the bony auditory canal The mastoid process is opened with a hammer and gouge though an electric burr is preferred by some The mastoid antrum must always be entered and the various groups of cells already mentioned (see p 380) must be sought and laid open. The operation is usually performed under cover of systemic disinfection by penicillin or sulphonamides. This permits stitching up of the postauricular incision except for a small drain in the lower part while the lips of the endaural incision may be allowed to fall together

The operation for *chronic suppuration* of the middle ear called *the radical mastoid operation* aims to throw the middle ear attic aditus and antrum into a single cavity It is the preliminary stage in operations for the relief of the intracranial complications of chronic middle-ear suppuration (Fig 201 (*b*) and (*c*)) This may likewise be performed via either a postauricular or endaural approach

At the end of Schwartze s operation there is left between the antrum and the attic a bridge of bone forming the outer wall of the aditus. This bridge is cut away and also the outer wall of the attic The bridge and posterior meatal wall may be cut away until the horizontal semicircular canal is exposed It can be recognised as a prominence of dense white bone in the floor of the aditus and must not be injured. The malleus and incus if present are removed and the whole cavity rendered smooth In curetting the tympanum and the opening of the Eustachian tube the facial nerve must be avoided It runs across the inner wall of the tympanum in the aqueduct of Fallopius and then turns down between the anterior extremity of the horizontal canal and the oval window towards the stylomastoid foramen. Consequently curetting from behind forwards is much less likely to cause damage than if the curette is used in the opposite direction. It is also necessary to avoid dislocation of the stapes an accident which would open the path for infection of the labyrinth Flaps cut from the skin of the posterior wall and roof of the auditory canal are used to help line the operative bony cavity Sometimes a Thiersch graft from the thigh is used to line the remainder of the cavity not covered by these flaps The cavity and the canal are packed lightly and the posterior auricular incision, if used sutured. Penicillin powder may be insufflated on the packing as it is being placed in position. With systemic disinfection it is usually not necessary to replace the packing before a week.

In the *fenestration operation* for otosclerosis the endaural incision is modified so as to allow the formation of a skin flap from the posterosuperior portion of the external auditory canal hinged on a partially mobilised tympanic membrane The incus and the head of the malleus are removed to facilitate access to the bony prominence of the external semicircular canal. Under magnification the canal is burred down so that only a thin shell of bone the cupola covers the endolymphatic canal The cupola is then elevated with a special knife to expose the intact membranous canal. The tympano-meatal flap is used to cover the newly formed window into the bony external semicircular canal

In the *operation for relief of attacks of vertigo* in Ménière s disease the procedure is similar except that as much as possible of the membranous canal is deliberately extracted.

J F SIMPSON

CHAPTER XXI

AFFECTIONS OF THE NOSE AND ACCESSORY SINUSES

SURGICAL ANATOMY.—The nasal cavity situated between the base of the skull and the roof of the mouth is divided by a median septum into two more or less symmetrical halves called the nasal fossæ. These communicate with the pharynx by the posterior nares or choanæ. The nasal fossæ are further subdivided into meatuses (Figs. 202 and 203) into which open the various ostia of the accessory sinuses. The nasal fossæ are roughly triangular in shape, the apex of the triangle being the narrow roof formed by the cribriform plate of the ethmoid while the floor is made up of the palatal processes of the maxillæ and the horizontal processes of the palate bones. The septum is made up of the quadrilateral cartilage in front, which articulates with the perpendicular plate of the ethmoid and the vomer behind. The posterior edge of the vomer divides the choanæ.

The lateral wall of each nasal fossa is a complicated structure. There are three overhanging scroll-like laminæ of bone called turbinates or conchæ running anteroposteriorly one above the other which divide the outer wall into a corresponding number of grooves or meatuses. The turbinates do not quite reach the front of the lateral wall, so that there is a smooth area in front of them, the upper part of which is called the agger nasi.

The inferior turbinate or maxillo-turbinate is an independent bone covered by a thick mucosa with ciliated epithelium and large venous spaces in the submucous tissue. It overhangs the inferior meatus into the anterior end of which the lachrymal duct opens.

The middle turbinate is a folded-over portion of the ethmoid and covers the middle meatus. The mucosa is rather tightly bound down to the underlying bone which is sometimes expanded by the presence of an ethmoidal cell in its anterior end.

The middle meatus is a most important and complex region and into it open the ostia of the anterior group of sinuses.

The fronto-nasal duct from the frontal sinus opens into the upper part of a semilunar groove, the prominent lips of which are formed by the bulging of underlying ethmoidal cells. High up on the posterior lip of the semilunar groove is a rounded projection called the bulla ethmoidalis, on the surface of which some of the ethmoidal cells open. Below this is a sharp crescentic lamella called the uncinate process. At the posterior edge of the semilunar groove is the opening of the maxillary antrum. This sometimes has an accessory opening still farther back.

The superior turbinate, also a projection from the lateral mass of the ethmoid, is much smaller than the middle or inferior turbinates. Behind and above its posterior end is a space called the spheno-ethmoidal recess into which open the posterior ethmoidal cells and the sphenoidal sinuses. The recess lies in the angle between the ethmoid and the anterior surface of the body of the sphenoid. It is rather narrow since the most posterior

ethmoidal cell is, as it were plastered on to the outer part of the anterior face of the sphenoidal sinus.

The nasal mucous membrane is usually divided into two portions, the pars respiratoria and the pars olfactoria according to the different function which each fulfils. *The olfactory portion which lines the upper third of the* outer wall of the nose and nasal septum has a thick greyish yellow folted

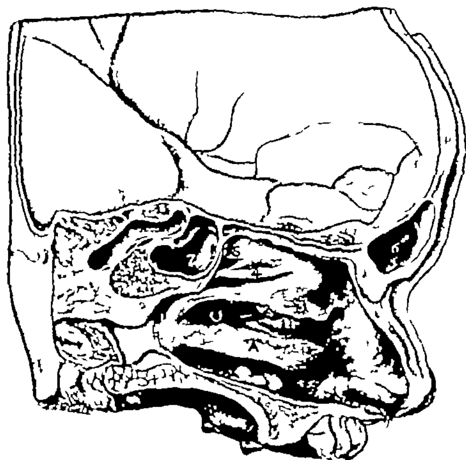


Fig. 202

A drawing showing the outer wall of the left nasal fossa

A, the inferior turbinal; 1 the uncinate process; 2, the bulla ethmoidalis, with the opening of the antrum immediately below and behind (a rod protrudes from it); 3, the middle turbinal; 4 the superior turbinal; 5 the spheno-ethmoidal recess; 6, the frontal sinus; the sphenoidal sinus; 8, the middle meatus.

appearance and contains bipolar perceptive olfactory cells the peripheral processes of which pass to the surface of the neuro-epithelium and end in *olfactory hairs* The central processes become grouped into about twenty bundles called the olfactory nerves and these pass through the cribriform plate pierce the meninges and so enter the olfactory bulb of the brain

The respiratory portion which lines the lower two-thirds of the nasal cavity and is continued through the ostia into the paranasal sinuses, is

covered by a columnar ciliated epithelium. The mucosa varies in thickness in different parts, and has a rich blood supply in the submucous tissue which shows in certain places definite cavernous plexuses. These are most marked over the inferior turbinate

The blood supply of the nose is mainly derived from the sphenopalatine artery (a branch of the internal maxillary) and the anterior and posterior ethmoidal arteries from the ophthalmic. The descending palatine and the pterygopalatine arteries (branches of the internal maxillary) also contribute a little

The venous system drains backwards into the sphenopalatine vein, forwards into the anterior facial vein and upwards into the ethmoidal

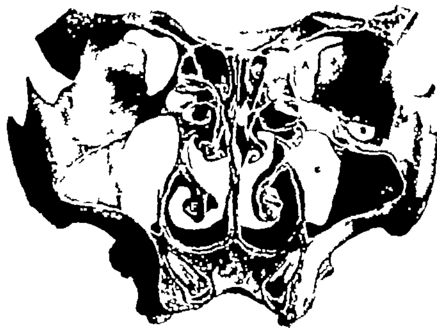


Fig. 203

A section through the bones of the face looking backwards. The orbits, antra and nasal fossae are shown.

D, E and F are the superior middle and inferior turbinals respectively

veins. These latter communicate with the ophthalmic vein, the veins of the dura and the sagittal sinus

The nerve supply is chiefly derived from the ophthalmic and maxillary divisions of the trigeminal. The back part of the cavity is supplied by the posterior superior and posterior inferior nasal nerves, the nasopalatine nerve and the anterior palatine nerves which come from the sphenopalatine nerve and ganglion The anterior part of the cavity is supplied by the anterior ethmoidal nerve from the ophthalmic division.

The lymphatics from the anterior part of the nasal cavity drain into the facial and submaxillary group of lymph nodes. There is a free anastomosis between the intranasal anterior lymphatics and those of the skin over the external nose The lymphatics from the posterior part of the cavity drain backwards to the lateral wall of the nasopharynx and then to the deep

cervical glands. Some lymphatics drain into the nodes of the retro-pharyngeal space and these appear also to be the destination of the main lymphatics from the paranasal sinuses.

THE NOSE

NASAL OBSTRUCTION

This is such an important factor in the predisposition to and the production of inflammatory conditions of the nose and accessory sinuses that it may be well to consider the chief causes of nasal obstruction that are met with before discussing the inflammatory conditions themselves

Cavities lined with mucous membrane are predisposed to inflammation when their drainage and ventilation is obstructed When any obstruction which may have been present is removed the inflammation in a large number of cases undergoes resolution. Obstructions may occur either on the medial wall or on the lateral wall of the nasal cavity and may be anterior or posterior They may also be behind the nasal cavity itself in the naso-pharynx The situation of the obstruction is of considerable clinical significance

Obstruction in the inferior meatus is mainly due to horizontal crests or spurs low down on the septum. These may diminish the air way through the inferior meatus and by causing turgescence lead to hypertrophy of the inferior turbinate which then adds further to the obstruction It is usually the anterior septal obstruction which, by creating a partial vacuum behind it leads to turgescence of the turbinate Apart from septal obstructions hypertrophy of the inferior turbinate from other causes such as sinus suppuration or adenoids may give rise to an almost complete blockage of the inferior meatus The drainage from the accessory sinuses is not interfered with by this type of obstruction

Obstruction in the middle meatus is a more serious affair High deflections of the septum, for instance may press on the middle turbinate and so lead to retention of secretions in and diminish the ventilation of the anterior group of sinuses

In addition to high deflection of the septum there are several conditions involving the outer wall which may cause obstruction in the middle meatus Amongst these anatomical abnormalities may be mentioned accessory cells in the middle turbinate overgrowth of the middle turbinate an accessory cell in the uncinate process or an enlarged bulla ethmoidalis (Fig 204) Pathological conditions such as nasal polypi and other manifestations of ethmoidal disease are potent sources of nasal obstruction When the olfactory sulcus is obstructed by septal deviation (or anomalies of the outer nasal wall) the drainage of secretions from and the ventilation of the posterior ethmoidal cells and sphenoidal sinus are impaired as these drain into that part of the superior meatus called the spheno-ethmoidal recess The hyperplastic changes in the mucosa which may be brought about

predispose these sinuses to infection and inflammation The importance of obstructive lesions in the nose as a factor in the production of disease should not be underestimated, as not only may they cause severe local troubles such as sinusitis but by interfering with the ventilation of the Eustachian tube predispose to middle ear infections whilst general development of the chest may be seriously affected as well as other more remote manifestations.

Deviations of the Septum

Malformations and deviations of the septum may be developmental or traumatic in origin. When traumatic the deflection is usually confined to the cartilaginous part but when developmental all the parts of the septum may be involved The type and situation of the deviation is not of so much significance as the degree of obstruction which is caused and this is not always easy to estimate by rhinoscopy A simple C-shaped convexity may show a concavity on the opposite side but there may also be a compensatory convexity farther back Crests, spurs and high deviations in the region of the perpendicular plate of the ethmoid cannot always be accurately defined, and it is very common to find at an operation a spur far back on the vomer which is touching the outer wall Very few people have a perfectly straight septum and it is only in cases in which the obstruction is severe enough to give rise to symptoms that treatment is called for The chief indications are interference with the function of the inferior turbinates and the prevention of ventilation of and drainage from the accessory sinuses.

Treatment —Every degree of septal deflection however limited or however complicated, can be dealt with by the operation of submucous resection. This may be carried out under either local or general anaesthesia The anterior end of the septal cartilage is dislocated into one nostril and an incision is made over this through which the mucosa and mucoperichondrium are raised from the cartilage. This is the most difficult step of the operation, and subsequent success depends on its proper performance Great patience is often required and the surgeon should not be content or anxious to proceed until he is satisfied that the elevator can be gradually pushed back along the cartilaginous and bony septum, following its twists and turns and raising the mucoperiostium from it This will not be a matter of great difficulty if the elevator is in the right plane and if the side and not the tip of the instrument is used to aid the stripping process The elevation should be carried upwards towards the cribriform plate and down to the floor of the nose whilst it should go backwards almost to the posterior part of the vomer The mucoperichondrial elevation of the other side should then be started by working round the exposed anterior edge of the septal cartilage and great care should be taken not to make any perforation in the mucosa of the opposite side When the elevation has been satisfactorily accomplished for both sides of the septum a long bladed speculum is inserted astride the cartilage and the mucoperichondrial flaps are thus held away from it All the

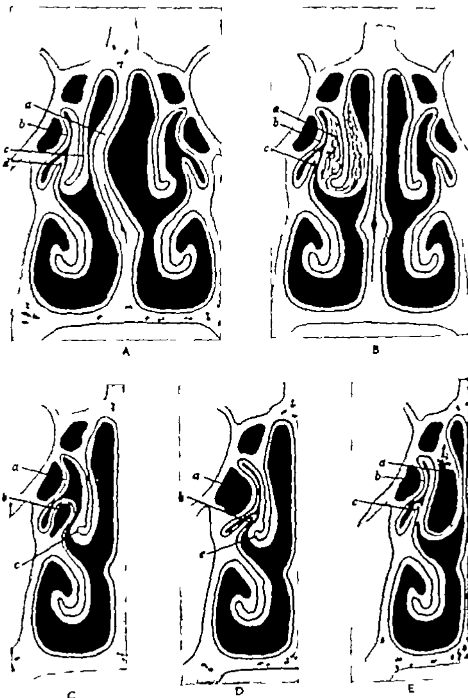


FIG. 204

Various types of nasal obstruction.

A, (a) high deviation of the septum; (b) bulla ethmoidalis; (c) middle turbinal; (d) uncinate process. B, (a) overgrowth of the middle turbinal; (b) bulla ethmoidalis; (c) uncinate process. C, accessory cell in the uncinate process; and D, enlarged bulla ethmoidalis. (a) the bulla; (b) uncinate process; (c) middle turbinal. E, (a) large accessory cell in middle turbinal; (b) the bulla; (c) uncinate process.

predispose these sinuses to infection and inflammation The importance of obstructive lesions in the nose as a factor in the production of disease should not be underestimated as not only may they cause severe local troubles such as sinusitis but by interfering with the ventilation of the Eustachian tube predispose to middle ear infections whilst general development of the chest may be seriously affected as well as other more remote manifestations

Deviations of the Septum

Malformations and deviations of the septum may be developmental or traumatic in origin. When traumatic the deflection is usually confined to the cartilaginous part but when developmental all the parts of the septum may be involved The type and situation of the deviation is not of so much significance as the degree of obstruction which is caused and this is not always easy to estimate by rhinoscopy A simple C-shaped convexity may show a concavity on the opposite side but there may also be a compensatory convexity farther back Crests spurs and high deviations in the region of the perpendicular plate of the ethmoid cannot always be accurately defined, and it is very common to find at an operation a spur far back on the vomer which is touching the outer wall. Very few people have a perfectly straight septum and it is only in cases in which the obstruction is severe enough to give rise to symptoms that treatment is called for The chief indications are interference with the function of the inferior turbinates and the prevention of ventilation of and drainage from the accessory sinuses

Treatment —Every degree of septal deflection however limited, or however complicated can be dealt with by the operation of submucous resection This may be carried out under either local or general anæsthesia. The anterior end of the septal cartilage is dislocated into one nostril and an incision is made over this through which the mucosa and mucoperichondrium are raised from the cartilage This is the most difficult step of the operation and subsequent success depends on its proper performance Great patience is often required, and the surgeon should not be content or anxious to proceed until he is satisfied that the elevator can be gradually pushed back along the *cartilaginous and bony septum following its twists and turns* and raising the mucoperiostium from it This will not be a matter of great difficulty if the elevator is in the right plane and if the side and not the tip of the instrument is used to aid the stripping process The elevation should be carried upwards towards the cribriform plate and down to the floor of the nose whilst it should go backwards almost to the posterior part of the vomer The mucoperichondrial elevation of the other side should then be started by working round the exposed anterior edge of the septal cartilage and great care should be taken not to make any perforation in the mucosa of the opposite side When the elevation has been satisfactorily accomplished for both sides of the septum a long bladed speculum is inserted astride the cartilage and the mucoperichondrial flaps are thus held away from it All the

Perforations due to lupus also involve the anterior cartilaginous part of the septum They are not usually clean-cut and show characteristic lupus nodules at the edges and in neighbouring parts of the mucosa

Perforations due to syphilis usually involve the bony part of the septum as well as extending forward into the cartilage They are often irregular in shape and if they extend high up may be associated with external deformity due to a sinking in of the nasal bridge

Small perforations may be closed by one of the usual surgical plastic devices but are often best left alone In some cases a whistling sound may be noticed on inspiration whilst in others crusting of mucus on the posterior edge of the perforation may give rise to excoriations and troublesome epistaxis

Epistaxis

Bleeding from the nose is a symptom of a large number of different conditions In children it is a common sign of adenoids It may occur in acute specific fevers such as measles scarlet fever diphtheria or typhoid whilst it is also found in many blood diseases such as hæmophilia arteriosclerosis anæmias etc It may be due to injury or to the presence of a simple or a malignant growth Nearly all spontaneous hæmorrhage from the nose arises from vessels on the anterior part of the septum just inside the vestibule This area is known as Little s or Kiesselbach s area When any excoriation of the mucosa over the plexus of vessels in this region occurs bleeding is apt to ensue This can usually be controlled by a small gauze plug In some cases the bleeding is very troublesome and intramuscular injections of hæmoplastin or the local application of snake venom may be helpful additions to the plugging The most satisfactory method of stopping bleeding from this region is by cauterising the bleeding area with the galvanocautery This seals up the vessels effectively When the bleeding comes from other parts of the mucosa chief reliance must be placed upon packing and, in some cases a post nasal plug may be required This is however seldom necessary and should never be left in for more than twelve hours at a time owing *to possible ill-effects on the ears and sinuses I have known cases of* hæmorrhage that persisted in spite of all treatment stop most dramatically when the patient was transfused

Profuse bleeding may occur from a hæmangioma of the septum and is likely to persist until the tumour is removed and its point of attachment cauterised Severe unilateral bleeding in elderly people should arouse suspicion of a malignant tumour if a possible septal origin can be excluded

Injuries to the Nose

Injuries to the nose are of common occurrence and may be caused by a fall or by a direct blow Fracture or dislocation may occur and this is often associated with damage to and deviation of the septum

In sinusitis there may be no pain whatever but its presence in and about the nose may be due to acute inflammation, to chronic inflammation, to pressure contacts in the nasal cavities due to abnormal anatomical conditions or to nasal new growths The character and degree of headache depend largely on whether the disease is capable of producing some form of pressure This is commonly present when the mucosa in a sinus is so swollen that abnormal contacts are produced or if, owing to a blocked ostium the products of inflammation are pent up in the sinus The negative pressure or so-called vacuum headache, if it exists at all, is difficult to prove but many believe with Sluder that it can cause intense pain in the frontal sinus region.

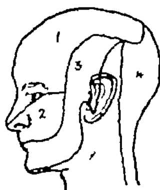


Fig. 205

Nerve supply of face and scalp. (After Skillern.)

1 2 and 3 are the divisions of fifth nerve, and 4 represents the occipital nerve.

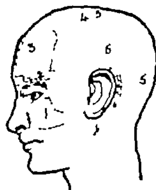


Fig. 206

Areas of referred pain in nasal sinusitis. (After Skillern.)

1, acute maxillary; 2 acute frontal; 3, chronic frontal; 4, chronic ethmoidal; and 5, chronic sphenoidal sinusitis.

In acute sinusitis there is usually a constant pain that is more or less localised in the region of the sinus and a neuralgic type which is periodic and occurs in the distribution of that branch of the trigeminal nerve that serves the affected sinus In chronic sinusitis the headache is more indefinite and not so well localised.

Fig 205 shows the surface areas supplied by the three divisions of the trigeminal, and also that supplied by the occipital nerves, whilst Fig 206 shows the areas to which pain is usually referred when the various sinuses are affected.

Intranasal pressure is often the cause of headache and is commonly due to high deviation of the septum and abnormal contact between the mucosa of the septum and that of the middle turbinate or to such degree of pressure on the turbinate that the ostia of the anterior group of sinuses may be partially occluded and their drainage and ventilation thereby impeded. Nearly all headaches from intra nasal pressure depend upon irritation of the sensory nerve endings in the mucosa by some pressure and the effect that such irritation produces on the sphenopalatine ganglion or the anterior ethmoidal nerves.

INFLAMMATORY DISEASES OF THE NOSE

Acute Rhinitis

A cold in the head is a very common condition, but its etiology is still uncertain and a satisfactory method of treatment has yet to be found. No specific organism is responsible but the typical symptoms are as definite and distinct as in many of the acute infectious diseases in which the specific organism has been isolated.

A fit of sneezing accompanied by a feeling of fullness or irritation in the nose is soon followed by a serous discharge which increases rapidly The nose then becomes blocked with loss of smell and headache due to extension of the inflammation to the mucosa of the accessory sinuses and with deafness due to extension to the mucosa of the Eustachian tube whilst general symptoms of malaise and chilliness sometimes accompanied by a rise in temperature, are often present. After a few days the discharge rapidly subsides but the inflammatory process may spread to the pharynx, larynx, or Eustachian tube.

If *treatment* is thought to be necessary it should begin by giving a very hot bath at bedtime followed by 10 gr of Dover's powder or ⅓ gr of omnopon. Local applications of menthol or camphor in liquid paraffin or insufflations of penicillin powder will relieve the congestion and obstruction, whilst tablets containing quinine belladonna and morphine may help to diminish the unpleasant symptoms. In the majority of cases the affection will run its course uninfluenced by treatment.

Chronic Hypertrophic Rhinitis

This is caused by those conditions which give rise to a chronic hyperæmia of the mucosa and a passive engorgement of the submucous venous spaces. It may result from repeated attacks of acute rhinitis and is frequently met with in patients suffering from sinus suppuration or in those who are constantly exposed to a dusty atmosphere or work amidst irritating fumes In cases of marked deviation of the septum the inferior turbinate on the concave side often undergoes hypertrophy but this is compensatory and is not of necessity pathological. The most common symptom is nasal obstruction. This varies with the state of the weather being worse in damp weather and in hot atmospheres. It is often worse at night the side of the nose that is resting on the pillow being the more obstructed This alternates if the patient turns over on to the other side This intermittent stenosis is often a characteristic feature of the condition.

On account of the nasal obstruction mouth breathing is developed with consequent secondary inflammation in the pharynx and nasopharynx, and the accumulation of sticky secretions that are difficult to dislodge This often extends to the Eustachian tubes producing a feeling of fullness in the ears and deafness

Examination of the nose shows the mucosa over the inferior turbinate to be engorged and hypertrophied often the anterior end

only is affected or there may be a fringe-like overgrowth along the lower border In some cases examination with the post-nasal mirror reveals a mulberry-like swelling of the posterior end.

The degree of hypertrophy cannot be estimated until the mucosa has been shrunk by the application of a pledget of wool wrung out in a 10 per cent. solution of cocaine This removes the swelling due to vascular engorgement and leaves the thickening due to true hypertrophy unaffected Treatment is determined by the amount of hypertrophy the severity of the symptoms and the underlying pathological conditions which may be found. Mild cases may be relieved by the use of 5 per cent argyrol drops or a watery spray of chloretone (0 5 per cent) sodium bicarbonate (0 5 per cent) glycerin (10 per cent) in normal saline (to 100 per cent) but if the degree of hypertrophy is at all severe reduction in the size of the turbinate is essential. This may be carried out with the galvano-cautery the red-hot wire being plunged through the mucosa and submucous tissue until the bone is reached. If this is done in several places the resulting scar tissue anchors the mucosa to the bone without undue sacrifice of the ciliated epithelium

Submucous injections of sclerosing fluid, such as a 5 per cent. quinine-urea solution or a 30 per cent. solution of carbolic acid in paraffin, are also used to effect a similar result by producing scarring in the vascular tissue of the submucosa and the adherence of the mucosa to the underlying bone If these measures fail, removal of the redundant tissue should be carried out with scissors and forceps or snare. Too much tissue should not be removed, and under no circumstances should the whole turbinate be sacrificed.

Atrophic Rhinitis

Atrophic rhinitis is an atrophy of the nasal mucosa and underlying soft tissues with eventual absorption of the bony inferior turbinate. The etiology of this disease is unknown, although many theories have been put forward to account for it Many investigators have tried to isolate a specific bacillus and at one time the *Bacillus fœtidus* of Perez was thought to be responsible, but this has not been proved. The most likely explanation is that put forward by Grünwald and others that it is due to undiagnosed sinus suppuration or purulent rhinitis in children from untreated adenoids In support of this latter view it may be mentioned that twenty five years ago cases of atrophic rhinitis were very commonly seen at hospitals but since children's tonsils and adenoids have been more efficiently treated atrophic rhinitis is a comparative rarity Some regard it as a deficiency disease and claim cures by treatment with fat-soluble vitamins

The pathological changes consist in a progressive atrophy of the mucosa and of the underlying turbinate bone with a destruction of the ciliated epithelium and its replacement by squamous or cubical epithelium. There is no ulceration, but the thick viscid secretion which is exuded has no cilia to move it on and dries to form crusts which decompose and give off the peculiar sickly stench that is so characteristic of the disease

When the nose is examined the nasal cavities are seen to be unusually roomy and filled with greenish crusts These may also be seen in the nasopharynx When the crusts have been removed the atrophy of the inferior turbinate and sometimes of the middle turbinate also allows structures on the outer wall such as the bulla ethmoidalis and uncinate process to be seen The posterior pharyngeal wall and often the Eustachian cushion come into view The only conditions that are likely to cause any difficulty in diagnosis are tertiary syphilis and suppuration in the accessory sinuses The absence of ulceration should exclude the former and the presence of atrophy the latter The prognosis as regards the cure of atrophic rhinitis is bad but it is always possible by suitable treatment to prevent the crusting and thus keep the main symptoms of fœtor and nasal obstruction in abeyance

The *treatment* mainly consists in cleanliness and in preventing the secretion from drying into crusts After the crusts have been removed by forceps and by syringing the nostrils should be packed with long strips of gauze soaked in a solution of 5 per cent ichthyol in glycerin 2 per cent protargol or crude cod liver oil This should be changed each day and the patients can be taught to do it themselves Once a week the mucosa should be painted by the surgeon with a solution of 1 1000 formalin If the treatment is carried out conscientiously the tendency to crust formation will begin to disappear in a few weeks and the mucosa will assume a more healthy appearance though it is doubtful whether the ciliated epithelium is ever regenerated. At this stage the question of diminishing the abnormal patency of the nasal cavities by surgical means should be considered There are several methods of effecting this those most usually adopted are the dislocation of the naso-antral wall inwards, as suggested by Lautenschläger and the submucous insertion of cartilage grafts on the floor of the nose and along the septum

Nasal Polypi

Nasal polypi are usually pedunculated tumours of hyperplastic tissue which commonly spring from the middle turbinate the uncinate process or the ethmoidal cells though they may arise in the maxillary frontal or sphenoidal sinuses They are no longer regarded as new growths and are purely inflammatory formations due to long-standing rhinitis or catarrhal sinusitis Microscopical examination shows them to consist of a loose fibrous stroma of which the meshes are filled with serous fluid. The surface is covered with ciliated columnar epithelium. They are often associated with a chronic osteitis or caries of the underlying bone There is another possible origin for the polypi and many observers consider that those which occur in vasomotor rhinitis hay fever bronchial asthma and some cases of non-suppurative hyperplastic sinusitis are primarily of allergic origin

Polypi almost invariably spring from some part of the lateral nasal wall and may be either pedunculated or sessile Sometimes the pressure of the œdematous masses distends the nasal cavity and causes an obvious broadening of the external nose.

Symptoms.—The symptoms are often complex on account of the nasal obstruction and the associated inflammation of the nose and sinuses which usually coexist. The leading symptom is generally nasal obstruction, but its onset may be so gradual as to pass unnoticed by the patient. Headache, watery discharge from the nose and loss of smell are often complained of. Sometimes there is a sensation as of a foreign body and, occasionally, the patient notices the polypus projecting in the nostril. Examination reveals the characteristic smooth glossy bluish grey swelling which is freely movable and which the use of a probe will show to be attached to the region of the middle turbinate.

Treatment.—This should consist in the thorough removal of the polypi, along with the bone to which they are attached. It will usually be advisable to deal surgically with any accompanying infection of the accessory sinuses, more particularly the ethmoidal labyrinth. Large single polypi, which are often seen in elderly people, may be removed under local anaesthesia with the cold wire snare, whilst polypi of allergic origin often respond to small doses of radium.

THE ACCESSORY SINUSES

These are a group of air-containing cavities which communicate with the nose by small openings or ostia. There is reason to suppose that they are residual olfactory organs which have, during evolution, been largely shut off from the nasal cavities. They play a considerable part in the production of serious disease of the face and head owing to their tendency to infection, whilst from their proximity to the brain and its coverings they are not infrequently the primary source of intracranial disease. Similarly, their close relation to the orbit may result in orbital cellulitis or abscess, whilst involvement of the optic nerve may give rise to impairment of vision. Mental disease may be due to inflammatory disease in the posterior group of sinuses.

Purulent secretion from infected accessory sinuses may be responsible for inflammatory conditions in other parts of the respiratory tract, while the swallowing of septic material from the sinuses may set up various digestive disorders and gastric disturbances.

ACUTE SINUSITIS

Acute inflammation of the mucosa lining the sinuses is due in the majority of cases to the extension of infection from the nasal cavities. The inflammatory processes may be simply catarrhal or may pass through the mucopurulent stage into acute suppuration in one or more of the sinuses. This, however, is more often the result of frequent attacks of acute inflammation than of a single attack. The resolution of inflammation depends on many factors, any one of which may affect adversely the return of the tissues to normal. When this inflammation takes place in closed cavities, the drainage from which may be interfered with in many ways, additional factors have to be taken into account. The only general one which

need be considered is the nature and virulence of the infecting organism Influenza is by far the most frequent cause of acute inflammation but any of the acute infectious disorders particularly scarlet fever may be responsible In the great majority of instances the infection is streptococcal but the pneumococcus or micrococcus catarrhalis is occasionally found in pure culture When the infection is a mild one and drainage is not interfered with, the local symptoms of sinus in volvement may be merged into those of the acute rhinitis which caused it, and so escape detection but if the infecting organism is of a virulent type the symptoms may be extremely severe the pain intense and intracranial complications be set up

Of the special factors which must be taken into account those that are of chief importance are conditions which prevent proper aeration of and drainage from the sinuses. Any form of nasal obstruction, whether it be a deflected septum, hypertrophied turbinates or nasal polypi may induce an undue congestion and œdema of the mucosa in some parts of the middle meatus, whereby the nasal opening of the frontal sinus is markedly obstructed or the drainage from the ethmoidal cells or maxillary antrum interfered with. Similar conditions affecting the superior meatus may prejudice recovery in inflammation of the posterior ethmoidal cells or sphenoidal sinus

Catarrhal Inflammation of the mucous membrane of the sinuses is common in any illness that is accompanied by acute rhinitis but retention of the discharge giving the clinical signs and symptoms of sinusitis is relatively uncommon. If acute inflammation with retention occurs the temperature is raised and general febrile symptoms with malaise are present When the frontal sinus and fronto-ethmoidal cells are involved there is tenderness on pressure in the supraorbital region and the inner canthus more particularly at the inner angle of the orbit against the floor of the frontal sinus. The pain has often a very definite periodic character beginning in the morning reaching its zenith at midday and gradually passing off entirely during the afternoon, only to reappear the next morning

When the antrum is affected the pain and tenderness are more localised to the nasal bone and malar region, but are very often frontal If the posterior ethmoidal cells and sphenoidal air sinus are involved the pain is referred to the occipital region.

These symptoms increase in severity if left untreated until the pressure in the sinus forces the contents through the natural opening and the pain is relieved by a gush of mucus, mucopus or blood-stained pus from the nose If relief is not obtained in this way an abscess forms which bursts through the bony wall of the sinus with the formation of an orbital or extradural abscess whilst extension through neighbouring lymph or venous channels may set up a meningitis or cavernous sinus thrombosis

In all acute inflammatory conditions in which extension occurs from the nasal cavity all the sinuses of the anterior group are usually infected, and the maxillary antrum is probably always involved no matter what other sinus is affected. The inflammation in the antrum may settle down quickly leaving the other sinuses to clear up later

or the other sinuses may clear up and leave the antrum still affected.

The maxillary antrum may be infected from another source, namely from the roots of the teeth, usually the second premolar and the first and second molars which project into the antral cavity and are separated from it only by a very thin plate of bone In cases in which the antrum is infected from an apical abscess or from faulty extraction this cavity alone may be involved

Examination of the nose by anterior rhinoscopy will show intense *congestion of the mucosa, and in some cases swelling of the inferior* turbinate, so that the upper part of the cavity cannot be seen until the swollen tissues have been shrunk by means of a 5 per cent. solution of cocaine It is important to see the middle meatus of the nose to ascertain whether there is any discharge beneath it that may be coming from the anterior group of sinuses. This may be absent particularly in frontal sinus cases but the middle turbinate itself will often be *seen to be swollen. The olfactory sulcus should be examined for the* presence of discharge and in all cases posterior rhinoscopy should, if possible be undertaken

Treatment—The main object of treatment is to diminish the congestion of the nasal mucous membrane more particularly in the region of the ostia, so as to facilitate the discharge of inflammatory products from the sinuses To achieve this result there are many things which *can be done both by the surgeon and by the patient The most valuable* procedure on the part of the surgeon is the placing of pledgets of cotton wool wrung out in a 10 per cent. solution of cocaine and 1 1000 adrenalin in the middle meatus and high up towards the spheno-ethmoidal recess After these have been in position for half an hour considerable contraction and ischaemia of the mucosa will be found to have occurred in the region of the hiatus semilunaris and the under *surface of the middle turbinate* and also in the posterosuperior region of the nose. This relief of pressure by the middle turbinate on the hiatus semilunaris will tend to promote a flow of mucopus from any of the anterior group of sinuses which may be affected. The introduction of cotton tipped probes dipped in cocaine solution will produce further ischaemia, and rapid improvement may be expected to occur after these applications. In every patient the infecting organisms are susceptible to penicillin which should be given in full doses for at least ten days.

The employment of an electric light head bath at a temperature rising to 170 and falling to 100 for half an hour is often useful *Short-wave diathermy for twenty minutes each day is also helpful.*

Additional measures for promoting discharge can be used by the patient Amongst these are hot saline douches and mentholised steam inhalations at frequent intervals These tend to stimulate the ciliary action of the epithelium and promote the flow of inflammatory products from the sinuses

Although the large majority of cases respond satisfactorily to these *measures there remain a few in whom discharge does not come away* freely more particularly when the maxillary antrum is involved.

In these a timely puncture of the antrum through the naso-antral wall and gentle lavage may be sufficient to turn the scale and obviate the necessity for surgical interference This procedure is often largely employed but is rarely necessary if efficient decongestive treatment is carried out Resistant cases have been reported as cured after several irrigations with penicillin even when the organism was a staphylococcus resistant to other therapy The strength of the solution used is 250 units per c c

If however expectant treatment should fail or the symptoms become aggravated some surgical treatment may be inevitable but this should be as limited in extent as is compatible with the evacuation of the retained discharge As regards the antrum a small intranasal opening may be made under the inferior turbinate and this is usually all that is necessary whilst for the frontal sinus and ethmoidal cells the dislocation of the middle turbinate or resection of its anterior end with the opening of the bulla ethmoidalis and the passage of a sound into the frontal sinus will usually suffice If an abscess should present externally in the region of the inner canthus simple incision and the insertion of a tube will be found to be sufficient any further operation on the affected cells or sinuses being delayed until the acute symptoms have subsided.

CHRONIC SINUSITIS

Chronic inflammation of the accessory sinuses may arise as a result of an acute inflammation which has failed to undergo resolution, or from repeated attacks of acute inflammation. In the antrum a chronic condition may be established owing to infection from a septic tooth without any previous acute attacks

In a good many cases the presence of chronic sinus suppuration is not suspected and is often discovered only in the search for a possible source of local or other sepsis Such local symptoms as bad breath bad smell, intermittent bad taste associated with nasal or postnasal discharge nasal obstruction, deafness pain and headache will call for a careful examination of the accessory sinuses

Chronic Suppuration in the Anterior Group

It is often difficult to determine which sinus or sinuses of this group is affected, as all of them have their openings in the middle meatus of the nose and any discharge from them will appear in some part of this cleft It is often only by a process of exclusion that the diagnosis can be established. As the maxillary antrum is very often affected and as it is easily accessible it is usual to try to exclude this cavity first

Examination of the nose after shrinking the swollen mucosa with cocaine may reveal pus in the middle meatus rather far back. If this is wiped or sucked away and the patient is asked to put his head down between his knees with the affected side uppermost so as to place the normal ostium in a good position for drainage further nasal examination may show that pus has reappeared in the cleft. This sign

(Fraenkel's) is a useful indication of the probability of pus in the antrum. Posterior rhinoscopy may show a streak of pus coming from the middle meatus over the posterior end of the inferior turbinate. We may next proceed to the transillumination test. A small lamp placed in the mouth of a normal patient in a dark room should illuminate the cheek bones, give a bright crescentic infraorbital tache and a red reflex through the pupils. If the antrum is affected a dark shadow may replace the infraorbital tache and the luminous glow of the pupil be absent. Fluid in the cavity does not always affect the test, but a thickened mucosa diminishes the translucency. The evidence afforded by transillumination may in itself be misleading and it should be considered



Fig. 207

Two X-ray prints showing A, the right antrum filled with fluid, and B, the right frontal sinus, in which a fluid-level is well defined.

as only a supplementary test. If it gives a positive result it may be confirmatory or arouse enough suspicion to justify an exploratory puncture. If negative it may point to other cavities as the source of the pus.

X-ray examination in a suitable postero-anterior position, which should be standardised, may show a blurred outline of the antrum or a definite fluid-level on one side, but the only really accurate test is puncture of the antrum and aspiration or washing out of pus from the cavity (Fig. 207).

The puncture is best effected under the inferior turbinate through the naso-antral wall. After previous cocainisation a straight or slightly curved trochar and cannula may be used. After aspirating the pus with the syringe some normal saline solution should be injected into the antrum and if the fluid from the nose is received into a basin it will be seen to contain flocculent pus.

If the diagnosis of antral suppuration is established by these means attention should then be directed to the possibility of the frontal sinus and anterior ethmoidal cells being also involved.

Examination of the nose may show a streak of pus far forward in the middle meatus just under the anterior end of the turbinate If this is mopped away it may reappear in five to ten minutes without the position of the head being altered

Transillumination is of little help owing to the varying thickness of the anterior wall but X ray examination will give most useful information both with regard to the possibility of thickening of the mucosa or of the existence of a fluid level (Fig 207) In some cases it may be possible to pass a suitably curved cannula up the frontonasal duct and into the sinus but often anatomical peculiarities make this im possible If it can be achieved, gentle suction may reveal the presence of pus The anterior ethmoidal cells are often involved in suppuration of the frontal sinuses or maxillary antrum but they may be affected alone There are two main types the hyperplastic type with polypus formation and a profuse watery discharge, and the purulent type with a granular appearance of the mucosa and excessive crust forma tion owing to the drying of the purulent discharge After careful removal of secretions the insertion of a long bladed Killian speculum under the middle turbinate and the forcing of the turbinate away from the uncinate process may enable the bulla to be seen and the site of the infection revealed.

Chronic Inflammation in the Posterior Group of Sinuses

This will show itself on anterior rhinoscopy by the presence of discharge in the olfactory sulcus or on posterior rhinoscopy by dis charge seen on the back of the septum on the lateral nasal wall near the Eustachian tube, on the upper surface of the posterior end of the middle turbinate or adhering to the roof of the nasopharynx. X ray examination in the vertico-mental position may show blurring of the posterior cells and sphenoid Puncture of the sphenoid and posterior cells may be carried out after the middle turbinate has been forcibly pressed aside by the blades of a long speculum

Treatment —The treatment of chronic inflammation in the accessory sinuses depends upon (1) the establishment of free drainage and aeration, (2) the removal of the cause if possible and (3) increasing the patient's resistance Chronic sinusitis with pronounced obstructive lesions necessitates the removal of the obstructive lesions whether they be of septal, turbinal or other origin so that the treatment will be essentially operative The method of displacement introduced by Proetz for diagnosis and treatment has been used extensively and is considered by many rhinologists to be of considerable value As a means of treatment displacement acts by the shrinkage of the mucosa by the introduction of ephedrine in 2 per cent solution.

Maxillary Antrum.—The establishment of drainage is achieved by making a large opening through the naso-antral wall under the inferior turbinate This may be done either under local or general anæsthesia Subsequent irrigation through the opening may be necessary It will generally bring about a cure of the condition In some cases in which the antrum has been infected from a tooth socket

or from a piece of root pushed up into it the approach through the canine fossa under the upper lip (Caldwell Luc operation) is advisable. This enables the cavity to be inspected, any foreign body removed, or polypoid mucous membrane to be dealt with A counter-opening through the naso-antral wall into the nose provides permanent drainage. The use of penicillin has been advocated as in the case of acute infections but though the cultures become sterile the discharge continues, and at operation the mucosa is found to be thickened with chronic inflammatory changes

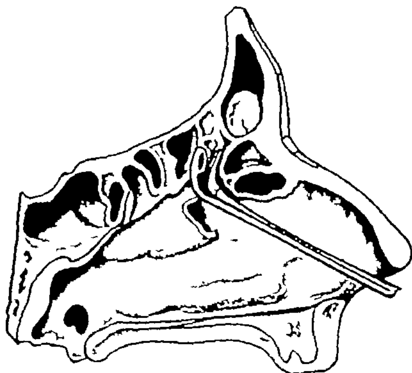


Fig 208

A drawing illustrating the disposition of cells round the fronto-nasal duct with the fronto-ethmoidal cells mounting up into the floor of the frontal sinus. Rongeur forceps are shown nibbling these cells away

Frontal Sinus.—When nasal obstruction is a marked feature on the affected side relief of this together with the removal of the anterior end of the middle turbinate will relieve pressure on the infundibulum, and the passage of a solid metal sound will overcome obstruction at the fronto-nasal opening It is not always easy or even possible to pass a sound into the sinus, and in such cases some abnormality of anatomical configuration is in all probability the reason. In these cases it will be necessary to remove the obstructing ethmoidal cells with a curette or biting forceps so as to allow a sound to pass into the sinus (Fig 208) A large number of cases will be cured by this procedure but it should be remembered that in many the anterior ethmoidal cells are simultaneously involved, and these must be removed if ascending infection of

the frontal sinus is to be avoided The majority of cases are cured by these intranasal methods but in some the headache tenderness discharge and eye symptoms persist Under these circumstances an external operation is advisable The one that gives the most satisfactory results is Howarth s operation This procedure consists in removing the floor of the frontal sinus along with the whole ethmoidal labyrinth making a new fronto-nasal duct by the removal of the nasal process of the frontal bone and the ascending process of the superior maxilla, and then lining this new fronto nasal duct with a skin graft

Ethmoid Labyrinth.—A large variety of operations has been devised for dealing with chronic inflammation in this region. In all cases some form of intranasal operation should be tried before resorting to the external approach. Partial or complete excision of the middle turbinate with removal of polypi and exenteration of the anterior ethmoidal cells is usually required but occasionally the opening of the bulla ethmoidalis and the anterior cells under the middle turbinate will suffice Complete exenteration of the whole lateral mass of the ethmoid by some such operation as Mosher s gives good results in advanced cases An external approach may be necessary when there is an external fistula or an orbital abscess or when intranasal operation has failed.

The Sphenoidal Sinus may be approached intranasally after removal of the middle turbinate or it may be dealt with by making a submucous resection of the septum and following the septum backwards and upwards until the anterior face of the sphenoid comes into view This transeptal operation gives excellent results The transantral approach is also useful in some cases If an external operation on the ethmoid labyrinth is being performed it is easy to extend the removal backwards to include the posterior ethmoidal cells and the anterior wall of the sphenoid

MUCOCELE is rather an unusual phenomenon that is occasionally found in relation to the sinuses It is characterised by a slowly increasing swelling that usually presents externally and gives the impression of a new growth rather than of an inflammatory swelling It is most frequently seen in the region of the inner canthus and arises from the ethmoid or frontal sinus. When of large size the swelling may displace the eye outwards and downwards. The contents of the mucocele are usually a thick glairy tenacious fluid, often containing cholesterin crystals. The origin of mucocele is doubtful It may be due to a low-grade inflammatory condition which has resulted in partial closure of the ostium or occasionally to an injury in the region of the ostium causing partial blockage Another view is that it is due to the development of cysts in the mucosa, either by the cystic dilatation of a gland or the cystic degeneration of a polypus. As the cyst like swelling increases in size considerable erosion and absorption of neighbouring bony structures may take place so that in advanced cases the ethmoid labyrinth may be converted into one large cavity continuous with the frontal sinus and a large area of the dura exposed.

Treatment consists in surgical approach by the external route and the establishment of a large track between the mucocele and the nasal cavity

COMPLICATIONS OF SINUS DISEASE

These may be orbital, ocular intracranial or general. Orbital cellulitis and abscess are not uncommonly seen in children as a result of ethmoidal disease, the infection passing through the os planum into the orbit It is seen more rarely in adults, and demands an external incision. Optic neuritis and retrobulbar neuritis may be due to disease of the ethmoid and sphenoid, whilst occasionally loss of vision may be due to septic absorption from infected sinuses Extradural and cerebral abscess meningitis and cavernous sinus thrombosis may be caused by direct extension of suppuration from the frontal sinus or ethmoidal labyrinth or indirectly by communicating veins whilst osteomyelitis of the frontal bones from infection of the diploe or of the superior maxilla is a dreaded sequela. This may arise spontaneously but far less often than as a result of operation so that it is imperative that no operation except antral lavage and incision of a subcutaneous abscess of sinus origin should be carried out during the acute stage of a sinusitis

SINUS INVOLVEMENT IN CHILDREN

Sinus infection in children is often overlooked, but it is undoubtedly more common than was formerly allowed. Routine examination of children who have infected tonsils and adenoids reveals the fact that a great many have infected maxillary antra The large majority clear up satisfactorily when the tonsils and adenoids are removed but in some, puncture of the antrum or the establishment of a small intranasal opening may be necessary

NEW GROWTHS

Growths of the nose may be either simple or malignant. Of the simple ones papilloma arising from the mucous membrane is very rare but warty growths are not uncommonly seen on the skin lining the vestibule Hæmangioma arises usually from the septum, and is often responsible for violent bleeding It may also grow from the ethmoid labyrinth. In this situation it tends to recur locally if not thoroughly removed Chondroma is a rare manifestation, but may originate in the septum, whilst osteoma is sometimes seen on the lateral wall, and in some cases in the sinuses themselves

Malignant neoplasms are, unfortunately *fairly* common. They usually start in some portion of the ethmoid labyrinth and spread downwards into the antrum, upwards into the frontal sinus or inwards into the nasal cavity In many cases they may involve a considerable area before their presence is suspected, but unilateral bleeding in elderly people is often significant of their presence.

Treatment is best carried out firstly by an operation of access in which an incision is made under the upper lip the mask of the face being lifted off the underlying bone structures. The tumour thus exposed may be removed by diathermy and it is remarkable what extensive growths can be charred away between two electrodes and removed piecemeal. Often one has to go up to the dura and back to

the nasopharynx In dealing with antral tumours the extension is often backwards to the pterygomaxillary fossa, and if this portion cannot be entirely removed by electrosurgery it is advisable to pack a dozen radium needles of 1 mg each into the cavity for four days

The operation of lateral rhinotomy (Moure) which used to be employed as a method of approach for these growths has been largely given up in favour of the procedure outlined above

Malignant growths of the sinuses do not appear to be of a severe degree of virulence so that a high percentage of cures may be looked for

ADENOIDS

Hyperplasia of the lymphoid tissue which is normally situated on the roof of the nasopharynx (the pharyngeal or Luschka s tonsil) is commonly called adenoids. It is however difficult to determine at what stage the amount of this lymphoid tissue ceases to be physiological and has to be regarded as pathological. This hyperplasia frequently follows one of the acute specific fevers, but undoubtedly occurs apart from infection and may perhaps be regarded as an exaggerated response of the defensive mechanism of the body in the process of acquiring immunity The underlying cause is however very obscure Some observers think it is due to improper feeding (excess of sugar and starchy foods) whilst others regard it as due to an essential vitamin deficiency or predisposed to by a general lack of nutrition.

Adenoid vegetations are met with in early life being most commonly seen between the ages of four and fourteen, but they occur in infants and may also be found in adults.

Adenoids are usually situated on the vault of the nasopharynx and may project downwards over the back of the septum thus partially blocking the choanæ or they may extend down the posterior pharyngeal wall and be seen without the aid of a post nasal mirror below the soft palate In some cases there are extensions round the mouth of the Eustachian tube

Adenoids are composed of masses of lymphoid tissue usually disposed in vertical ridges They are not encapsuled in any way which accounts for their varying shape and situation.

The *symptoms* vary with the degree of hyperplasia. In advanced and long-standing cases the picture of chronic nasal obstruction is produced. There is mouth breathing by day and snoring at night The nares become pinched, the palate high and arched, the jaw underhung and the mouth always open. Mentality is dulled, the expression is vacant and the so-called adenoid facies is produced.

Many cases are seen long before such marked changes occur and come under observation on account of ear troubles nasal symptoms or general reflex disturbances

Those with ear symptoms are brought complaining of deafness which is usually due to Eustachian tube obstruction or aural discharge. The deafness often varies with the weather and is usually worse with a cold The tympanic membranes are retracted, and occasionally there is a perforation through which a sticky mucopus exudes

The nasal symptoms that are complained of are snoring at night, mouth breathing during the day recurrent attacks of cold in the head a tendency to choking or snuffling whilst eating and a constant mucoid nasal discharge

The general symptoms that are most usually noticed are listlessness inability to concentrate and general apathy and dullness These are often associated with restless sleep night terrors and nocturnal enuresis, whilst the physical development is poor and the chest flat and retracted owing to imperfect expansion of the lungs

Diagnosis—The diagnosis is seldom in doubt and is often made from the symptoms but examination with the post nasal mirror will reveal the adenoid mass and show its extent Children tolerate examination with the mirror very well indeed, and it should seldom be necessary to make a digital palpation of the nasopharynx.

Treatment—The fact that adenoids are present does not of necessity mean that they should be removed, and when they are not causing any symptoms they should be left alone as otherwise the defensive mechanism of the patient may be upset Proper breathing exercises and the instillation of 2 per cent argyrol drops will often suffice for mild cases but when the symptoms are marked no time should be lost in removing the growths

When operation is decided on it is best done under general anæsthesia with the child lying on its back and the head extended. The mouth is opened with a Doyen's or Sydenham's gag, and some form of guarded curette is usually employed. This is introduced behind the soft palate and pushed firmly backwards against the vault of the nasopharynx and then drawn downwards with a sweeping movement along the posterior pharyngeal wall, a certain amount of pressure being maintained at the same time The main mass of adenoids that lie centrally and are caught in the hooks attached to the curette come away in one piece Small outlying masses may be removed with a ring knife or Löwenberg's forceps

Some surgeons prefer to use a La Force adenotome for the operation, but this instrument is not suited to cases in which there is any depression in the nasopharyngeal wall due to an abnormally projecting vertebral body

After the operation the child should be turned on its face and the bleeding stops in a few moments. Rest in bed is essential for a few days if aural or other complications are to be avoided.

WALTER HOWARTH.

CHAPTER XXII

THE PHARYNX AND ŒSOPHAGUS

SURGICAL *Anatomy of the Pharynx and Œsophagus* —The pharynx has a muscular a fibrous and a mucous coat The muscular coat is composed of the inferior middle and superior constrictors with slips from the stylopharyngeus and palatopharyngeus These flat muscles are inserted posteriorly into a median raphe attached above to the basilar process of the occipital bone The inferior constrictor overlaps the middle which in turn overlaps the superior The lower fibres of the inferior constrictor arising from the cricoid are almost horizontal and are continuous with the muscular coat of the oesophagus while the upper fibres arising from the thyroid cartilage ascend obliquely over the lower part of the middle constrictor towards the median raphe The lower portion, which forms the oesophageal sphincter is sometimes described as the cricopharyngeus, and it is in the interval between the lower horizontal and upper oblique portions that a pharyngeal pouch herniates through the wall of the pharynx.

The pharyngeal aponeurosis or fibrous coat is dense where the muscular coat is absent i.e., in the intervals between the origins of the constrictor muscles.

The mucous coat containing mucous glands and lymphoid follicles, is continuous with that of the upper air and food passages.

The isthmus of the fauces, by which the mouth opens into the pharynx is bounded above by the soft palate and laterally by the anterior and posterior pillars formed by the palatoglossus and palatopharyngeus Between these pillars which represent parts of the second and third branchial arches lie the tonsils. The supratonsillar fossa at the upper part of the tonsil represents the remnant of the recess in the wall of which the tonsil is developed. The outlet is narrowed by a fold of mucous membrane the plica semilunaris stretching across the angle at the junction of the pillars with the soft palate The supratonsillar fossa or crypta magna is thus part of the tonsil. Another fold, the plica triangularis stretches backwards from the anterior pillar and blends with the surface of the tonsils but has a free crescentic margin directed inwards and backwards, and so forms a kind of sling for the tonsil

On its deep surface the tonsil is not in direct relation to the superior constrictor of the pharynx, but is separated from it by the palatopharyngeus. This muscle spreads out behind and sends a slip the tonsillopharyngeus, to be directly attached to the tonsil. In a tonsil removed by a clean dissection the remnant of this attachment may be seen dividing the tonsil into upper and lower segments

The lymphoid tissue on the back of the tongue forms the lingual tonsil. On either side are the palatine or faucial tonsils and above lies the adenoid tissue of the pharyngeal tonsil in the nasopharynx, with outlying extensions at the mouth of the Eustachian tube There is a further connecting band of lymphoid tissue often enlarged behind the posterior pillar of the fauces

and other outlying follicles in the pharynx. This forms Waldeyer's ring which drains into a wider lymphatic area than do the tonsils alone but all this lymphoid tissue is confined to the neck.

At the lower border of the cricoid cartilage opposite the 6th cervical vertebra the pharynx becomes continuous with the oesophagus, which extends for 9 or 10 in. down to the 10th or 11th dorsal vertebra. The abdominal portion is about 1 in. in length. The distance from the teeth to the cardiac orifice is about 16 in. (40 cm) but often rather more. The oesophagus is narrow (1) at its upper opening, (2) where it is crossed by the aorta and the left bronchus and (3) at its passage through the diaphragm. It is at these situations that foreign bodies are apt to lodge and malignant disease to develop.

Examination of the Pharynx and Œsophagus.—Only a reflecting mirror or headlight and a tongue depressor are necessary to examine the oropharynx. The condition of the palate, teeth gums tongue and floor of the mouth should be noticed at the same time, and also the movements of the soft palate. To expose the tonsils and detect pus concealed in the crypts, a second tongue depressor of small size held in the other hand is useful. The nasopharynx should be surveyed with a small mirror. To examine the laryngopharynx the use of the laryngoscope is essential (see p. 454).

The hypopharynx, the lowest part of which lies behind the larynx and ends at the lower border of the cricoid, can be seen only by endoscopy.

Examination of the oesophagus is now confined to radiography and oesophagoscopy. Auscultation gives no reliable information and there is no longer any reason for the use of bougies in diagnosis. They should only be used for dilatation when introduced under vision through the oesophagoscope. For radiography the patient should swallow a paste consisting of 2 oz. of subcarbonate of bismuth or barium sulphate mixed with milk and breadcrumbs. This will show on the screen or in a radiogram, as a dark shadow the outline of a dilatation, stricture or pouch.

The cardinal symptom of oesophageal disorders is dysphagia, usually of gradual onset and, unless the cause is revealed by examination of the mouth and pharynx which may show some obvious ulceration, the oesophagoscope should always be employed after preliminary radiography. The presence of an aneurysm compressing the oesophagus should always be excluded by physical examination and radiography before passing the oesophagoscope. The tubes are similar to those used for bronchoscopy but are larger longer and require no lateral fenestrations.

FOREIGN BODIES IN THE PHARYNX

Large foreign bodies in the laryngopharynx such as a tooth plate, a bone or a coin, may lodge behind the larynx in the region of the cricoid and cause only pain and dysphagia until removed with laryngeal forceps but a large piece of meat impacted over the entrance to the larynx will cause sudden asphyxia. Unless the foreign body is hooked out with the finger or laryngotomy is performed at once the accident is immediately fatal. Consequently such specimens are common in museums. There is in the museum of the Middlesex Hospital a specimen which displays a billiard ball impacted at the entrance to the larynx.

Small foreign bodies especially pins and fish bones, may stick in

the fauces, the back of the tongue the pyriform fossa or the tonsils Pain aggravated by swallowing is the chief symptom but is not a reliable guide as the patient may refer unpleasant sensations to a point at some distance from the actual situation of the foreign body

The whole pharynx including the nasopharynx and the larynx should therefore be searched *thoroughly after spraying with* a weak solution of cocaine before concluding that no foreign body is present This is often the case as the disagreeable sensation caused by a slight abrasion persists after the foreign body has passed onwards Great care, however is required not to overlook a fish bone which is difficult to see and may be im bedded with only a small part projecting Slight hæmorrhage or a small hæmatoma sometimes gives a clue It is important to remove such foreign bodies as soon as possible as an acute in flammation of the pharynx may be caused If the wall of the pharynx is perforated surgical emphysema may result and still worse cellulitis of the neck may cause hæmorrhage from the great vessels mediastinitis or even spinal meningitis. When located the foreign body must be removed. The endoscopic removal of foreign bodies is usually preferred but those situ ated in the hypopharynx may sometimes be removed by Mackenzie s angular laryngeal forceps guided by a mirror



FIG. 209

A specimen showing a "merry thought" impacted in the œsophagus.

FOREIGN BODIES IN THE ŒSOPHAGUS

A variety of foreign bodies impacted in the œsophagus is recorded, but the common ones are in adults tooth plates or bones (Fig 209) and in children, coins (especially halfpennies) or safety pins Sometimes pieces of meat or fruit stones which normally would pass easily become impacted above a stricture so that the onset of dysphagia in cancer of the œsophagus is sometimes sudden.

The majority of foreign bodies stick in the upper third of the œsophagus and a coin is nearly always seen by X rays opposite the top of the sternum lying in the coronal plane (Fig 210) If the coin is lying with its diameter anteroposteriorly it is probably in the trachea. *A foreign body occasionally remains for long periods in the œsophagus without producing dysphagia* or doing much harm, but it is likely at some time to produce ulceration followed by mediastinitis perforation of the trachea or of a large vessel. Foreign bodies should

therefore be removed without unnecessary delay but not as a rule without localisation by X rays and no attempt should be made without suitable instruments. It is better to leave a coin in position a little longer than to remove it with a coin catcher which though it succeeds may cause a serious accident A bougie should never be used.

The diagnosis is usually obvious from the history and X ray examination, but some objects such as chicken bones or fish bones are non-opaque Pledgets of cotton wool soaked with barium paste when swallowed often stick to a non opaque object and thus mark its position



FIG 210

An X ray photograph of a halfpenny in the common situation in the œsophagus, i.e. opposite the top of the sternum.

In removing the foreign body by the œsophagoscope care is to be observed that the beak of the instrument does not glide past an object lying high up in the hypopharynx or gullet. A small tube also may easily pass an object concealed in the folds of mucous membrane which would be opened out by a larger tube Metallic objects may be so changed in appearance that they are not easily recognised, or may be embedded in an inflammatory mass

A foreign body such as a rabbit bone lying across the lumen should be seized by the tip and not near the middle so that it swings into the long axis of the gullet The same applies to a tooth plate but if this is large it is sometimes necessary to divide it with endoscopic shears as it is an object very likely to lacerate the wall of the œsophagus Special instruments have been designed for closing safety pins lying open with the point upwards but the best method is to protect the point with the end of the œsophagoscope and grasp the pin by the clasp External œsophagotomy is very rarely necessary

DISEASES OF THE PHARYNX

ACUTE PHARYNGITIS

Simple catarrhal pharyngitis is part of an ordinary coryza or of one of the infectious fevers or may accompany an attack of acute tonsillitis. The mucous membrane shows only slight inflammatory swelling and congestion of a transient character Streptococcal infection of the pharynx, sometimes called acute septic pharyngitis

presents far more acute and serious symptoms. The mucous membrane of the pharynx becomes swollen purple and glazed with great enlargement of the uvula and in severe cases sloughing of the tonsils and gangrene of the uvula follow The œdema may spread down to the aryepiglottic folds and cause dyspnœa or if the infection has its origin in dental sepsis, it may extend to the neck and cause a diffuse brawny swelling (Ludwig's Angina). The patient is always gravely ill and may be delirious, with a swinging temperature showing remissions accompanied by sweating The breath is fœtid and dysphagia is severe The pulse is bounding and rapid but soon becomes feeble and the patient may succumb rapidly from exhaustion or later from mediastinitis or pleurisy The urine should always be examined for albumin and sugar and care is to be taken in making the diagnosis that the condition of the pharynx is not masking an attack of scarlet fever or diphtheria

Treatment—Penicillin is the most useful general remedy though occasionally other organisms than the streptococcus hæmolyticus are found. If septicæmia ensues systemic chemotherapy is invaluable Hot applications to the neck and spraying the pharynx with weak adrenalin can be recommended

In Ludwig s angina incisions in the neck may be required but they seldom reach a collection of pus Tracheotomy is occasionally required for the relief of dyspnœa

Streptococcal infection may produce a membranous pharyngitis indistinguishable from diphtheria, and occasionally the appearance of Vincent's angina is membranous rather than ulcerative

In agranulocytic anæmia severe tonsillitis and pharyngitis going on to gangrene and sloughing are usually rapidly fatal. Blood examination shows a leucopenia with a relative lymphocytosis The application of X rays to the long bones and injections of pentnucleotide liver extract and yellow bone marrow to produce granulocytopoiesis are recommended Blood transfusion is only temporarily effective

In leukæmia also a similar condition in the pharynx may be encountered. Therefore bacteriological investigation should never be omitted and a blood count is often essential to establish a correct diagnosis

Vincent s Angina is usually seen as an ulcer with a membranous exudate limited to the tonsil often secondary to a gingivitis round the teeth Severe cases may be met with in debilitated subjects living in insanitary and crowded conditions, when the ulceration may spread to involve the buccal surface of the cheek and pharynx. In the 1914-18 war many such cases were seen and termed trench mouth Occasionally a cellulitis may spread down the neck to the mediastinum. The infection is caused by a symbiosis between the bacillus of Vincent and a spirillum The bacillus is fusiform 6 to 8 μ in length and 1 μ in breadth It may contain vacuoles be arranged in pairs or radiating bundles and be mobile The organism does not stain by the method of Gram but by the ordinary basic stains and can be cultivated in broth to which ascitic fluid has been added. The spirillum is long sinuous and very mobile and does not stain so readily as the bacillus. It cannot be cultivated

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The ulcer on the tonsil is irregular with sharply cut edges, the floor being covered with a yellow membranous slough. It must be differentiated from that due to syphilis further a somewhat similar type of shallow ulceration is due to avitaminosis (B_2 complex) and this can often be relieved by nicotinic acid.

Treatment.—Penicillin is the method of choice but cure can be effected by injection of arsenic and bismuth. As soon as the infection is under control attention must be turned to the peridontal disease

TONSILLITIS

Acute tonsillitis is classified as catarrhal, lacunar or parenchymatous according to its degree of severity In the common lacunar form, often called follicular the crypts become filled with desquamated epithelium, fibrin, pus cells and organisms forming white or grey dots at the mouths. In the parenchymatous form the whole tonsil and the adjacent pharynx become swollen and infiltrated, and an abscess may form in the substance of the tonsil

The disease usually occurs in young adults and sometimes in children. In children it may precede an attack of acute rheumatism, so that removal of the tonsils slightly diminishes the frequency of primary attacks but the operation has no influence in preventing recurrent attacks nor does it influence the incidence of endocarditis.

Acute inflammation is particularly liable to occur in the remnants of tonsils which have been partially removed, and in tonsils which are the site of chronic inflammation or suppuration. The specific fevers especially scarlet fever often begin with an acute attack of parenchymatous tonsillitis The commonest causal organism by far is the streptococcus pyogenes but varieties of pneumococci and staphylococci are also found either pure or in mixed infections. In the epidemic streptococcal form the contagion may be carried by milk. The initial symptoms are malaise and anorexia, sometimes with a chill or even a definite rigor The temperature rises to 102 or 104 F with corresponding increase in the rate of the pulse, which is full and bounding There is pain in the throat radiating to the ears and increasing difficulty in swallowing with much salivation.

The condition must be distinguished from diphtheria and Vincent's angina by bacteriological examination Parenchymatous tonsillitis may indicate the onset of scarlet fever before the appearance of the rash. Mild cases must be distinguished from secondary syphilis The illness usually lasts from four to eight days

The faucial type of glandular fever resembles severe tonsillitis. The cervical glands enlarge, and there is both a relative and absolute lymphocytosis The spleen may be enlarged. The illness may last several weeks but the prognosis is good.

Treatment —The systemic administration of penicillin or sulphonamides provides the most effective means of treatment but salicylic acid and codeine are also required to relieve the pain the former being most effective in the form of a suspension in mucilage Pain may also be relieved by a paint containing 2 per cent of β-eucaine in glycerin.

Gargles are useless and increase the pain but a compress to the neck either hot or cold often gives relief Junket ice-cream custard and thick soups are foods easily swallowed The dysphagia may be relieved by an attendant standing behind the patient with the palms applied behind and below the angle of the jaw on either side Firm pressure is made just as the patient swallows If the disease is recurrent after eliminating such causes as dental sepsis or external sources of infection the tonsils should be removed but not until after an interval of six weeks.

QUINSY

The formation of a peritonsillar abscess or quinsy (Fig 211) which is usually unilateral, is shown by increasing œdema of the uvula and the appearance of a tense swelling on one side of the soft palate, which bulges downwards and forwards The abscess should not be allowed to burst through the soft palate or into the tonsillar fossa but should be opened with sinus forceps at its most prominent point after painting with 10 per cent. cocaine A yellow spot often indicates the point at which the pus may be most easily reached, but if this has not appeared, the centre of a line between the base of the uvula and the upper wisdom tooth may be chosen A peri tonsillar abscess may occasionally be opened through the supra tonsillar fossa.

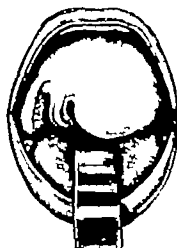


FIG. 211

A peritonsillar abscess.

Much less commonly a quinsy presents behind the lower half of the tonsil. In this case there is some danger that the pus may track along the carotid sheath if the opening for drainage is not placed suitably and it may not be possible to reach the pus without removing the tonsil. This provides very free drainage and healing is rapid and simple.

A rare but grave complication of quinsy is hæmorrhage from erosion of one of the large vessels in the immediate neighbourhood

RETROPHARYNGEAL ABSCESS

This is caused by suppuration in the glands of Henle situated between the posterior pharyngeal wall and the prevertebral aponeurosis. It usually occurs in children, often as a complication of one of the infectious fevers On rare occasions the pus tracks down from the mastoid process The child suffers from dysphagia and dyspnœa due to the tongue falling

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Acute tonsillitis is classified as catarrhal, lacunar or parenchymatous according to its degree of severity In the common lacunar form, often called follicular the crypts become filled with desquamated epithelium, fibrin, pus cells and organisms forming white or grey dots at the mouths. In the parenchymatous form the whole tonsil and the adjacent pharynx become swollen and infiltrated, and an abscess may form in the substance of the tonsil

The disease usually occurs in young adults and sometimes in children In children it may precede an attack of acute rheumatism, so that removal of the tonsils slightly diminishes the frequency of primary attacks but the operation has no influence in preventing recurrent attacks nor does it influence the incidence of endocarditis.

Acute inflammation is particularly liable to occur in the remnants of tonsils which have been partially removed and in tonsils which are the site of chronic inflammation or suppuration The specific fevers especially scarlet fever often begin with an acute attack of parenchymatous tonsillitis The commonest causal organism by far is the streptococcus pyogenes but varieties of pneumococci and staphylococci are also found either pure or in mixed infections. In the epidemic streptococcal form the contagion may be carried by milk. The initial symptoms are malaise and anorexia, sometimes with a chill or even a definite rigor The temperature rises to 102° or 104 F with corresponding increase in the rate of the pulse which is full and bounding There is pain in the throat radiating to the ears and increasing difficulty in swallowing with much salivation.

The condition must be distinguished from diphtheria and Vincent's angina by bacteriological examination. Parenchymatous tonsillitis may indicate the onset of scarlet fever before the appearance of the rash. Mild cases must be distinguished from secondary syphilis. The illness usually lasts from four to eight days

The faucial type of glandular fever resembles severe tonsillitis. The cervical glands enlarge and there is both a relative and absolute lymphocytosis The spleen may be enlarged. The illness may last several weeks but the prognosis is good.

Treatment—The systemic administration of penicillin or sulphonamides provides the most effective means of treatment but salicylic acid and codeine are also required to relieve the pain the former being most effective in the form of a suspension in mucilage Pain may also be relieved by a paint containing 2 per cent of β-eucaine in glycerin.

Gargles are useless and increase the pain but a compress to the neck either hot or cold, often gives relief Junket ice-cream custard and thick soups are foods easily swallowed The dysphagia may be relieved by an attendant standing behind the patient with the palms applied behind and below the angle of the jaw on either side Firm pressure is made just as the patient swallows. If the disease is recurrent after eliminating such causes as dental sepsis or external sources of infection the tonsils should be removed but not until after an interval of six weeks.

QUINSY

The formation of a peritonsillar abscess or quinsy (Fig 211) which is usually unilateral is shown by increasing œdema of the uvula and the appearance of a tense swelling on one side of the soft palate which bulges downwards and forwards The abscess should not be allowed to burst through the soft palate or into the tonsillar fossa but should be opened with sinus forceps at *its most prominent point, after* painting with 10 per cent cocaine A yellow spot often indicates the point at which the pus may be most easily reached but if this has not appeared, the centre of a line between the base of the uvula and the upper wisdom tooth may be chosen. A peri tonsillar abscess may occasionally be opened through the supra tonsillar fossa.

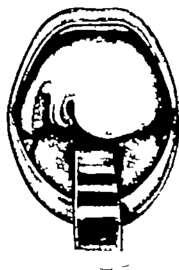


FIG. 211

A peritonsillar abscess.

Much less commonly a quinsy presents behind the lower half of the tonsil. In this case there is some danger that the pus may track along the carotid sheath, if the opening for drainage is not placed suitably and it may not be possible to reach the pus without removing the tonsil. This provides very free drainage and healing is rapid and simple

A rare but grave complication of quinsy is hæmorrhage from erosion of one of the large vessels in the immediate neighbourhood.

RETROPHARYNGEAL ABSCESS

This is caused by suppuration in the glands of Henle situated between the posterior pharyngeal wall and the prevertebral aponeurosis It usually occurs in children often as a complication of one of the infectious fevers. On rare occasions the pus tracks down from the mastoid process. The child suffers from dysphagia and dyspnœa due to the tongue falling

back against the swelling which is not usually in the middle line but lies behind one tonsil Palpation as well as inspection is important in diagnosis If unrelieved the abscess may burst and flood the larynx and trachea with pus or track down into the posterior mediastinum The child should be held on its side with the head down and the face turned rather downwards. The abscess may then be opened without an anæsthetic with a guarded knife or sinus forceps

A chronic form of retropharyngeal abscess arises in children from tuberculous caries of the cervical spine producing the same symptoms of which the earliest may be nasal obstruction To avoid septic infection such an abscess should be opened through an incision behind the sternomastoid. The posterior edge of the muscle is exposed, the carotid sheath with its contents is drawn forward and the position of the transverse process defined before the abscess is opened. Large acute abscesses are better opened by this route than by the internal

CHRONIC PHARYNGITIS

This shows itself by a congestion of the mucous membrane over the soft palate fauces and uvula which may be elongated In the so-called granular pharyngitis hypertrophied patches of lymphoid tissue occur on the posterior pharyngeal wall In pharyngitis sicca the mucosa becomes dry and atrophic The symptoms are dryness tickling *and cough. Local causes are chronic tonsillitis nasal obstruction or* the discharge from an accessory sinus of the nose Excessive smoking, the abuse of alcohol and faulty voice production in professional speakers are important factors General conditions such as gout, diabetes, *arteriosclerosis and cardiac disease are as important as local causes.*

Pathological conditions in the nose should be corrected, and a simple gargle or the astringent Trochisci Krameriæ may be given Disorders of digestion require attention and patients may be sent for spa treatment to Harrogate

In the Plummer Vinson (*syn* Paterson Brown Kelly) syndrome which occurs only in middle-aged women, dysphagia accompanied by achlorhydric anæmia, is the cardinal feature The skin is dry and there are cracks at the corner of the mouth The dysphagia is due to chronic glossitis and atrophy of the mucous membrane of the pharynx and œsophagus where chronic inflammatory and degenerative changes in the plexus of Auerbach have been found. Blood examination shows microcytic anæmia with low colour index and a few normoblasts but no megaloblasts The administration of iron in large doses is indicated. It is a precancerous condition (p 467)

CHRONIC TONSILLITIS

Enlargement or hypertrophy of the tonsils is sometimes regarded as synonymous with chronic inflammation, but in fact size is no criterion of this and in many small children some hypertrophy of the tonsils appears to be a physiological necessity rather than a pathological reaction.

The tonsils may be large but often especially in adults are small flat and concealed by the pillars of the fauces There is a chronic infection of a crypt especially of the crypta magna or supratonsillar fossa from which pus may be expressed A chronic abscess may form in the substance of the tonsil usually in a deep situation near the capsule

Collections of epithelial scales forming cheesy masses in the crypts are often troublesome but are not necessarily an indication of chronic infection A deep crimson band of congestion may be seen along the anterior faucial pillar Such tonsils may be of importance as sites of focal sepsis causing arthritis muscular rheumatism or nephritis.

Indigestion and retching are frequent *symptoms* The breath may be foul and the patient notice a bad taste in the mouth There is often a reflex cough with general symptoms of fatigue and anæmia from toxic absorption.

Treatment—Paints containing iodine or resorcin may be tried in adults and blocked crypts slit up with a small knife or the electric cautery Unless there is some general contraindication it is better to remove the tonsils especially if there is a history of recurrent acute tonsillitis or quinsy or any pronounced cervical adenitis In small children simple hypertrophy or a single attack of tonsillitis is not sufficient reason for removal of the tonsils as the need for lymphoid tissue at that age to develop immunity and defensive reactions leads to recurrence and hypertrophy elsewhere especially of the adenoid tissue in the nasopharynx. The principal criteria for removal are recurrent attacks of acute tonsillitis or of quinsy and the enlargement of the lymphatic glands just below and behind the angle of the jaw

Removal of the Tonsils—In children up to the age of 15 years it is feasible to remove tonsils entire by the guillotine this is possible also in many adults but as a rule, in order to ensure complete removal, dissection is preferable The choice of operation in individual cases is determined by the practice of the operator but when there is a history of quinsy the line of cleavage around the capsule is difficult to define and the guillotine operation may be impossible. Whichever method is employed the whole tonsil should be removed, especially the lower pole from which the tonsil may reproduce itself In exceptional cases, even when tonsillectomy has been complete, the tonsil may be reproduced from the lingual portion and provide a target for the critical.

In children a general anæsthetic is required for dissection, but ethyl chloride is sufficient for the guillotine operation. In adults the general anæsthetic is usually delivered through an intratracheal tube The patient should be kept relaxed but should regain the reflexes quickly after the cessation of the anæsthetic so as to minimise the possibility of the inhalation of blood. Local anæsthesia by a novocain and adrenalin solution injected into the fauces round each tonsil is sometimes employed

When the guillotine is used the patient lies supine with the shoulders a little raised and the head extended The mouth is opened with a Doyen gag placed between the front teeth but not wide enough to stretch the anterior faucial pillars. The ring of the guillotine held in the right hand is passed under the lower pole of the right tonsil with the handle pointing to the left of the patient. The handle is then depressed so that the tonsil is levered

on to the alveolar eminence at the posterior end of the mylohyoid ridge, which forces it through the ring (Sluder) To complete this movement the forefinger of the left hand is applied to the anterior faucial pillar (Whillis), and the whole tonsil can be felt to slip through the ring The blade is then pushed home Care is to be taken that the blade passes between the anterior pillar and the tonsil so that the edge is not nipped. The tonsil is then removed by pronating the hand The left tonsil is removed by changing the guillotine to the left hand or by standing behind the head of the patient. By this method the tonsil with its supratonsillar fossa is removed complete in the capsule which is often everted in the process. Two sizes of guillotine should be available

In removal by dissection the patient lies supine with the head either dropping far back or tilted over to the right side. Under general anæsthesia the mouth is opened with a Davis gag which gives a good view of the tonsils by forcing down the base of the tongue with the patient lying on the back. The reflection of mucous membrane between the anterior pillar and the tonsil is incised or torn through with scissors or long bladed dissecting forceps. Suitable forceps must be used to hold the tonsil and draw it out of its bed. The dissection is best done by teasing out the tonsil with the long bladed dissecting forceps, so that the vessels are torn across and retract There is then very little bleeding and ligatures are not always required The tonsil is thus shelled out of its bed but it often remains attached by the lower pole to the lingual tonsil at the base of the tongue from which it has to be divided with scissors or by a snare.

Careful sponging or the use of an electric suction pump is necessary to keep the field of operation clear from blood. The only artery likely to bleed persistently is the tonsillar branch of the facial, which enters the tonsil about the middle of its bed on the posterior pillar If it does not retract it should be picked up with long forceps and underrun with a silk ligature on a half-circle round bodied needle Bleeding may continue after the guillotine operation from a button holed vein which cannot retract. If there is a persistent oozing of blood or post-operative hæmorrhage deep silk ligatures should be passed through both pillars and tied. The stitches should be removed the following day and not allowed to cut out.

If the mucous membrane covering the edge of the anterior pillar is kept intact there is usually not much post-operative pain, but this varies and can be controlled by Euphagin or a suspension of aspirin in mucilage. Adults should receive an injection of morphia on the night following the operation.

KERATOSIS

Small, white adherent excrescences are sometimes seen scattered over the tonsils. These were formerly thought to be caused by the leptothrix buccalis which is sometimes present and the condition was called pharyngomycosis True mycosis does occur but is extremely rare These sickle-shaped projections are formed by an abnormal proliferation of highly keratinised epithelial cells They occur not only on the faucial tonsils but also on the lingual tonsil and sometimes on the soft palate Unless this distribution is observed the appearance can easily be mistaken for lacunar tonsillitis but there are no symptoms beyond slight discomfort or roughness in the throat The patient is usually a young female

No *treatment* is of any avail, but the condition disappears spontaneously

TUBERCULOSIS OF THE PHARYNX

Apart from tuberculous deposits in the tonsils tuberculosis of the pharynx is nearly always, but not invariably secondary to pulmonary tuberculosis It occurs much less frequently than laryngeal tuberculosis and usually heralds a rapidly fatal termination Miliary tubercles become deposited in the mucous membrane and produce patches of ulceration. Single discrete tuberculous ulcers are much less common This form of ulceration is very painful and causes much dysphagia Applications of orthoform powder or cocaine may be necessary to allow the patient to eat General treatment is similar to that of laryngeal tuberculosis (p 459)

Lupus causes a more chronic form of ulceration, which may heal in one place while it spreads in another with the formation of characteristic nodules. The contraction of the thin scar tissue causes much deformity of the soft palate and fauces Sometimes the posterior wall of the pharynx only is affected General *treatment* with calciferol (synthetic vitamin D) and streptomycin has provided a great advance in therapy virtually displacing all others Occasionally local therapy with the Kromayer light lamp or electro-coagulation is used in addition

SYPHILIS OF THE PHARYNX

The tonsil is said to be the commonest site of extragenital chancre. It appears as an indolent ulcer with enlargement of the glands at the angle of the jaw but the general inflammation of the tonsil obscures the classical characters of the chancre which may be concealed. The unilateral situation distinguishes it from tonsillitis, but if the possibility of the correct diagnosis is forgotten it may be mistaken for carcinoma Vincent's angina or a gumma The examination of a scraping for the treponema pallidum and before long the appearance of a secondary rash will settle the diagnosis

Secondary Syphilis shows itself by symmetrical crescents of erythema on the anterior pillars and velum palati The tonsils are often enlarged at the same time Mucous patches appear in any part of the pharynx. They are round or oval, slightly raised and surrounded by a narrow inflammatory areola. The surface is covered by a thin opalescent membrane They produce a sore throat and dysphagia.

Tertiary Syphilis produces severe effects in the pharynx A diffuse or circumscribed gumma may break down and produce a superficial serpiginous ulcer which is characteristic, or deep ulceration with sharply cut edges and a yellow slough covering the base This latter causes great destruction and healing is followed by gross scarring and deformity especially on the posterior pharyngeal wall and soft palate which may be perforated or become a mass of cicatricial tissue Adhesion of the palate to the posterior pharyngeal wall may narrow or entirely obliterate the opening between the oropharynx and nasopharynx.

Dysphagia is the chief *symptom* but perforation of the palate

produces also regurgitation through the nose and a nasal voice while adhesions cause partial or complete nasal obstruction sometimes with deafness General *treatment* is of great importance but plastic operations for the restoration of a passage between the oropharynx and nasopharynx or attempts at dilatation give only discouraging results

NERVOUS AFFECTIONS OF THE PHARYNX

In **globus hystericus** there is no visible change The sensation of a lump rising in the throat is probably due to spasmodic contraction of the constrictor muscles

Nystagmus of the pharynx may be due to disease of the central nervous system such as tabes dorsalis or to some local cause of reflex irritation The soft palate moves up and down as often as sixty times a minute sometimes with a clicking sound The vocal cords also are sometimes implicated The lesion is said to be in the olive

Paralysis of the pharynx may be caused by central nervous disease in tabes syringobulbia and disseminated sclerosis It may also be peripheral in origin and result from the toxins of diphtheria and influenza or is sometimes an early symptom of myasthenia gravis.

If the paralysis is bilateral the soft palate hangs downwards and forwards and reflex movements cannot be elicited When the paralysis is unilateral as it may be in syringobulbia, the uvula is drawn towards the sound side while the paralysed half of the palate is lower and less arched. The voice is nasal and there is nasal regurgitation of fluids on swallowing If the constrictors are affected there is increasing difficulty in swallowing especially fluids It should always be noticed at the same time whether there is paralysis of the vocal cords and tongue The tongue deviates to the paralysed side on protrusion and fibrillation may be observed in the paralysed half. In progressive bulbar paralysis the hypoglossal nucleus with its morphological continuation backwards is affected, so that the tongue and muscles attached to the hyoid bone are paralysed but the pharyngeal muscles and intrinsic muscles of the larynx escape The dysphagia and dysphonia are due to inability to fix the larynx which by its weight stretches the palatopharyngeal muscles The atrophy of the mylohyoids and digastrics renders the patient unable to open the mouth widely and as the larynx cannot be fixed laryngoscopic examination is difficult or impossible (see p 404)

PHARYNGEAL POUCH

A pressure pouch (Fig 212) sometimes called a Zenker's diverticulum arises as a small pouch in the posterior median line of the hypopharynx. It emerges between the oblique and transverse portions of the inferior constrictor muscle and as it enlarges and sags downwards it becomes the direct continuation of the pharynx the œsophageal opening lying concealed in front As more and more food enters it the pressure

on the back of the œsophagus increases and with it the dysphagia The pouch may eventually sag down into the posterior mediastinum where radiography will display a characteristic retort shaped shadow (Fig 213)

The majority of the patients are elderly men, whose symptoms are long-standing dysphagia and regurgitation of undigested food Sometimes a swelling which can be emptied by pressure appears in the neck after eating Cough is caused by the overflow of liquids from the pouch, and the patients become slowly emaciated. Occasionally malignant disease supervenes at the orifice. Relief may be obtained by washing out the decomposing food with a funnel and tube but removal of the pouch gives good results This is performed in one stage under cover of prophylactic disinfection by penicillin. An oblique incision is made along the anterior border of the sternomastoid under local anæsthesia if necessary The carotid sheath is exposed and retracted. The pouch which consists of thickened mucous membrane and connective tissue is dislocated out of its bed and severed at its junction with the pharynx The edges of the gap in the pharynx are closed by two layers of sutures C P Wilson suggests that the pouch may be reached at its neck by rotating the larynx forwards after division of the middle thyroid veins and superior thyroid artery so as to expose the back of the pharynx The sac is drawn up and after division and closure of the neck Zenker's triangle is obliterated by sutures The patient is usually tube fed for the next four to five days

Recently an endoscopic

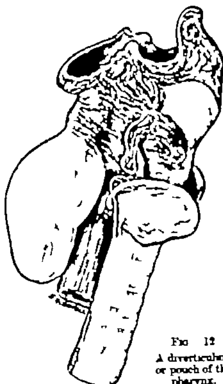


FIG 12
A diverticulum or pouch of the pharynx.



FIG 13
A semilateral view of a pharyngeal pouch shown by radiography

method of dividing longitudinally the party wall between the pharynx and the sac with an electric cautery has been devised.

TUMOURS OF THE PHARYNX

Benign Tumours of the oropharynx with the exception of papilloma, are rare but adenoma fibroma lipoma angioma and both simple and dermoid cysts have been recorded. Papilloma occurs on the tonsils, faucial pillars soft palate and uvula

Such tumours often give no symptoms but if causing cough from irritation of the pharynx, if interfering with speech or deglutition, or if increasing in size they should be excised. A tumour such as an angioma likely to cause hæmorrhage should be removed by diathermy

Malignant Tumours of the oropharynx include sarcoma carcinoma and salivary gland tumours Any form of sarcoma or a mixed tumour may occur The usual site is the tonsil about puberty An enlargement of one tonsil should always be regarded as suspicious of malignant disease A smooth prominent swelling appears which may easily be mistaken for a quinsy and is associated with some enlargement of the lymphatic glands at the angle of the jaw Ulceration, fungation and hæmorrhage appear relatively later than in carcinoma though the course of the disease is rapid

In order to establish an exact diagnosis so that the treatment may be appropriate a piece of the tumour is removed for microscopic examination. The use of the diathermy knife is recommended for this in order to avoid hæmorrhage and the risk of dissemination

CARCINOMA is usually squamous-celled and attacks the fauces, tonsil and soft palate The lower part of the anterior pillar is said to be the usual site of origin. From there it soon spreads to the tonsil and the side of the tongue. The glands at the angle of the jaw become enlarged at an early stage but are not invariably affected. There is discomfort and salivation associated later with pain radiating to the ear Later still hæmorrhage dysphagia and general wasting follow

It may easily be mistaken for an ulcerating gumma, especially if the Wassermann test happens to be positive, but the edge of a carcinoma is hard and raised and not so sharply cut as that of a gumma.

LYMPHO-EPITHELIOMA, described by Schminke and Regaud arises in lympho-epithelial tissue The tumours consist of epithelial cells and lymphocytes intimately connected. The epithelial cells grow in sheets and show no signs of differentiation or of epidermoid evolution. The lymphocytes fill up the syncytial network formed by the epithelium. This form of epithelioma is rare, but is of importance because it is highly sensitive to treatment by radiation, and no attempt should be made to treat it by excision. If a squamous carcinoma is detected at an early stage the tumour can be excised through the mouth. The cheek is retracted, the palatoglossus divided near the tongue and the tumour excised with a wide margin by means of the diathermy knife.

The approach to these tumours however is dominated by the mandible and if the tumour is no longer in quite an early stage, or has reached the side of the tongue the lower jaw must be either

divided or partially excised in order to expose it This is the only possible method of treatment if the tumour has become attached to the inner aspect of the angle of the jaw

The best method is to ligature the external carotid first and then to make a long incision through the lower lip and to carry it backwards below the horizontal ramus The mandible is then divided a little towards the same side and the whole of that half of the mandible is removed along with the tumour attached to it by disarticulating it at the temporomandibular joint The pharynx must be carefully reconstructed by an inner and outer row of stitches catgut being used for the inner layer in the mucous membrane. The patient must be fed with a tube and the lymphatic glands excised later The operation has the disadvantage of inflicting a mutilation, but the patient can eat in comfort after it and talk reasonably well, and a number have survived the operation many years without recurrence



FIG. 214

A drawing illustrating cardiospasm. The increase in length and the sigmoid bend are well seen.

If the tumour is not fixed to the jaw and has not a syphilitic basis, treatment by radiation offers a promising alternative in the form either of X ray therapy or tele-radium Sarcoma and lympho-epithelioma give better results than squamous carcinoma, but good results can be obtained with the last when the tumour is still confined to its site without local infiltration and the lymphatic glands show no enlargement or if palpable are still movable and would be removable by operation Treatment by surgery and irradiation may be combined.

Tumours of the laryngopharynx are described for convenience with tumours of the larynx.

DISEASES OF THE ŒSOPHAGUS

ŒSOPHAGECTASIA

This condition of the œsophagus is described also as achalasia or cardiospasm The œsophagus is dilated and hypertrophied and is obstructed at the lower end (Fig 214) The patients are usually but not invariably women and the disease progresses slowly for many years The obstruction at the lower end is functional rather than

mechanical. There is increasing dysphagia with emaciation, and the dilated gullet contains undigested but decomposing food and liquids. There is occasional regurgitation The œsophagus becomes lengthened and the dilatation affects chiefly the lower end so that instead of being spindle-shaped it usually becomes sigmoid. The mucous lining is inflamed and ulcerated with patches of leukoplakia and polypoid hyperplasia Eventually carcinoma may supervene The circular muscle becomes hypertrophied and the plexus of Auerbach has been found to be degenerated and inco-ordination from want of relaxation (achalasia) has been suggested as a cause

In addition, phrenospasm, on the view that the obstruction is



Fig. 215

The X ray appearance of an early stage of cardiospasm.



Fig. 216

The X-ray appearance of an advanced stage of cardiospasm.

at the diaphragm and not at the cardia, and congenital malformation have been suggested as etiological factors

Radiographic examination after the administration of a barium meal shows enormous dilatation of the œsophagus terminating in a funnel-shaped extremity passing to the left towards the cardia (Figs. 215 and 216) The weight of the fluid may cause the lower part of the dilated gullet to sink below the level of the diaphragmatic opening

On examination with the œsophagoscope a large quantity of turbid fluid is encountered and should be removed by suction. The œsophagoscope can be passed into the cardia without difficulty Relief can be given by washing out the œsophagus regularly with a funnel and tube The usual treatment is repeated dilatation of the cardia by means of a bougie containing mercury and this can be done regularly by the patient. Heller's operation is another method of treatment In this the muscular fibres at the lower end of the œsophagus

are then divided without encroaching on the mucous membrane on the same principle as in Rammstedt's operation on the pylorus (p 613) Endoscopic dilatation with a hydrostatic bag frequently gives prolonged relief

DIVERTICULUM OF THE ŒSOPHAGUS

Traction diverticulum is usually situated near the bifurcation of the trachea where the left bronchus crosses the œsophagus and is caused by enlarged tracheobronchial glands becoming adherent to the wall of the œsophagus. The traction is caused by movements of respiration and deglutition

Pulsion diverticulum is still more rare Epiphrenic diverticulum occurs in the lower part of the œsophagus on the left side and is formed by a hernia of the mucous membrane through the longitudinal muscle fibres

These conditions do not usually call for any treatment but excision of the diverticulum has been successful in a few cases

RUPTURE OF THE ŒSOPHAGUS

The œsophagus is very intolerant to the passage of instruments by which the wall can be damaged easily unless great care is exercised Spontaneous rupture is rare and only occurs during vomiting or violent retching but probably never in a healthy œsophagus. It is always seen in the lower third in the long axis and is followed by severe pain in the epigastrium and shock so that the symptoms resemble those caused by perforation of a gastric ulcer The resulting mediastinitis is usually fatal in about twenty four hours.

CICATRICIAL STENOSIS OF THE ŒSOPHAGUS

This is rarely the result of disease but it may follow ulceration caused by syphilis or scarlet fever and sometimes other fevers It more commonly is due to swallowing corrosive fluids whether by accident or with suicidal intent Such strictures caused accidentally are comparatively common in America and Eastern Europe The stricture is apt to form where the fluid comes into closest contact with the lining of the œsophagus i.e. at the narrowing caused by the crossing of the left bronchus The healing of the ulceration may however produce multiple strictures. If the stricture is impermeable jejunostomy is urgently necessary It will be possible later to excise the stricture by the left transpleural approach and bring the stomach up and anastomose it to the œsophageal stump If the stricture is permeable it may be very gradually dilated by bougies passed through the œsophagoscope never blindly Another method is to perform gastrostomy and give the patient a silk thread to swallow The end of the thread is found in the stomach with the aid of a cystoscope and brought out through the gastrostomy Graduated metal olives are threaded on the silk in groups of three on an endless chain which passes

through the mouth down the gullet through the stricture out of the gastrostomy and after cleansing back into the mouth again. This treatment is very prolonged but is capable of yielding satisfactory results

CONGENITAL SHORTENING OF THE ŒSOPHAGUS

Some cases of dysphagia especially in children but also in older patients are explained by congenital shortening of the œsophagus, which ends at the level of the VIIth dorsal vertebra The stomach is thus partly thoracic and there may be an associated diaphragmatic hernia (p 601) There may be a stricture from chronic inflammatory



Fig. 217

Carcinoma of œsophagus at level of the aortic arch, as revealed by a barium swallow



Fig 218

Carcinoma of the œsophagus at the cardiac end, as revealed by a barium swallow

changes at the junction of the short œsophagus and the thoracic stomach. The normal function of the cardia being in abeyance regurgitation of gastric juice into the œsophagus produces peptic ulceration a cause of severe pain Recent studies suggest that the shortening of the œsophagus is due to insufficiency of sphincteric control at the hiatus, which allows regurgitation of gastric juice and so causes peptic ulceration This in turn produces spasm of the longitudinal fibres and so shortening of the œsophagus This accounts for the frequency of the clinical condition which is seen at œsophagoscopy and radiologically whilst it is seldom if ever encountered at autopsy when the spasm has relaxed The stricture should be treated by dilatation under endoscopic vision. Postural treatment is also of help in preventing regurgitation of gastric juice Persistent ulceration will demand a transpleural resection and anastomosis.

MALIGNANT DISEASES OF THE ŒSOPHAGUS

The most common cause of œsophageal obstruction is malignant disease An ulcerating squamous-celled carcinoma is the usual form (Fig 219) but occasionally the lower end of the gullet is invaded by a carcinoma of the stomach or a spheroidal-celled carcinoma may develop in a nest of gastric mucosa in the lower œsophagus Sarcoma is quite rare Metastases seldom occur but local extension to glands or pleura and perforation of the trachea or left bronchus are common, so that recurrent laryngeal paralysis broncho-pneumonia or pulmonary gangrene may be late effects Perforation of the aorta is rare The *majority of patients are males, and the* middle and lower thirds of the gullet are the usual sites In the upper third it is less common but in that situation it usually occurs in females and in the absence of pronounced dysphagia may be mistaken for primary malignant disease of the thyroid gland which has been invaded from behind.



Fig. 19

Œsophagus from a case of cardiospasm. A squamous celled carcinoma has arisen in the dilated œsophagus.

Painless dysphagia accompanied by rapid wasting is the only early symptom. The disease occasionally runs its course without causing dysphagia, ulceration of the growth maintaining the gullet patent A mass of glands at the root *of the neck may be the first indication* or there may be dyspepsia or cough or symptoms arising from the invasion of surrounding structures

Examination by X ray before a screen may show slowing of the opaque fluid at the level of the aorta or obstruction at the cardia with filling of the œsophagus alone or the passage through a stricture An X-ray photograph will usually demonstrate the situation and degree of the stenosis The length may be estimated by inverting the patient so that the fluid indicates the lower extremity of the stricture There is little or no dilatation above a malignant stricture (Figs 217 and 218).

The *diagnosis should be confirmed by* œsophagoscopy *and a* portion of growth may be removed for microscopic examination

Treatment —Whenever possible surgical removal of the growth

should be undertaken When the cervical œsophagus is affected a complete segment may be removed by an operation along the lines of lateral pharyngectomy and the resultant gap bridged by a skin flap so as to form a gutter which is closed later If these high growths are invading the larynx this must be removed at the same time

Growths of the thoracic œsophagus are approached by a left thoracotomy If the growth is found to be operable the left cupola of the diaphragm is incised and the stomach completely mobilised. The œsophagus is freed and the dissection carried well above the growth, and the gullet divided at this level and also severed from the stomach which is brought up into the thorax and sutured to the upper end of the œsophagus.

Inoperable growths often respond well to X ray therapy for a time Indeed impassable malignant strictures may yield so that normal feeding is restored in weeks or months Eventually a gastrostomy will become necessary

J F SIMPSON

CHAPTER XXIII

THE LARYNX

SURGICAL *Anatomy of the Larynx*—The principal cartilages of the larynx are the thyroid and cricoid which can be palpated on external examination of the neck. The notch in the upper border of the thyroid cartilage is easily felt even in a fat short neck and is often visible in males, so forming an unfailing landmark. The body of the hyoid bone lies above it but the great cornu on either side is more easily felt than the body Palpation of the thyroid cartilage with the forefinger in the notch and the thumb and second finger on each wing gives a fair idea of the size of the larynx which is smaller and softer in women than in men. It is also higher in women and partially concealed by the chin. Lateral movement on the oesophagus and front of the spine normally produces a distinct click.

An interval occupied by the cricothyroid membrane separates the lower border of the thyroid from the ring of the cricoid cartilage which in adults is opposite the 6th cervical vertebra and rather higher in children. A lymphatic gland called after Poirier lies on the front of the cricothyroid membrane Below the cricoid the cricotracheal membrane connects it to the trachea, of which there are about seven or eight rings in the neck, but the length of trachea in the neck depends on extension of the head, whereby the trachea can be pulled up out of the thorax for an inch or more The thyroid isthmus lies in front of the 3rd and 4th tracheal rings but it may cover a larger area. The whole length of the trachea, which reaches to the 4th dorsal vertebra is about 4½ in in the adult

In ordinary quiet breathing the larynx scarcely moves but in laryngeal obstruction it is drawn forcibly down towards the thorax at each inspiration, which is accompanied by stridor In tracheal stenosis the movement of the larynx is much less while stridor caused by the dyspnoea accompanies both inspiration and expiration.

Inspection with the laryngoscope should include many structures besides the vocal cords which bound the glottis On the base of the tongue are the circumvallate papillae and the foramen caecum the lymphoid follicles forming the lingual tonsils and the central and two lateral glosso-epiglottic folds. These connect the epiglottis with the base of the tongue and enclose the right and left vallecula on either side The *epiglottis* slightly yellow from the underlying yellow elastic fibrocartilage projects up behind the base of the tongue but it may curve backwards and overhang the entrance to the larynx. On either side the free border merges with the aryepiglottic folds, which pass obliquely downwards and backwards to the tips of the arytenoids and enclose the cartilages of Wrisberg The arytenoid cartilages articulate below with the cricoid cartilage on which they rotate so that the glottis opens and shuts Their apices project upwards and backwards and support the cartilages of Santorini, which are sometimes very prominent The ventricular bands or false vocal cords, are folds of mucous membrane lying above the true cords but farther apart, so that normally the glottis is visible. Below and outside the ventricular bands are the ventricles of the larynx, the

openings of which lie between the true and false cords The subglottic region is narrow immediately below the cords but widens so that the upper rings of the trachea and occasionally its bifurcation are often visible in the mirror

The *hypopharynx* or laryngopharynx lies behind the larynx and extends down to the lower border of the cricoid cartilage where it joins the oesophagus. Only the upper part is visible as far down as the arytenoid cartilages, but on either side a narrow opening bounded internally by the aryepiglottic fold and externally by the thyroid ala leads down to the fossa pyriformis This opening is widened on phonation and it should be observed whether the pyriform sinus is being properly drained or whether the entrance is occupied by a pool of mucus or mucopus

The *vocal cords* are formed by the upper free edge of the cricothyroid membrane (conus elasticus) A layer of dense fibrous tissue below the thin mucous membrane gives a white appearance to the cords.

Methods of Examination.—Examination with the laryngeal mirror shows an image reversed in the anteroposterior direction and because the patient faces the examiner right hand structures are seen in the mirror on the examiner s left (Fig 220).



Fig. 220
The larynx in normal quiet breathing as seen by laryngoscopy

The larger the mirror that can be used conveniently the better the view The reflecting surface is warmed over a spirit lamp to prevent cloud of moisture condensing on the glass, and the back of the mirror tested on the cheek or the dorsum of the hand to avoid the risk of burning the palate of the patient. This is of particular importance if cocaine has been applied to abolish the pharyngeal reflex The patient must raise his head open his mouth wide and protrude his tongue fully without holding his breath The tongue is held with a tongue cloth between the thumb and second finger and the first finger is used to raise the upper lip. The laryngoscope is usually held in the right hand but it is wise to practise holding it in the left hand so that forceps can be used with the right hand while the patient holds his own tongue The mirror is made to follow the curve of the tongue and then applied firmly to the soft palate and uvula. Using the soft palate as the fulcrum the various parts are brought into view by tipping the mirror Steady pressure without touching other structures does not excite the pharyngeal reflex, but if the pharynx is very irritable a little 5 per cent cocaine may be applied to the palate This is rarely necessary *if the examination is not made too soon after a meal.*

If only the posterior part of the larynx is brought into view the patient must say eh which raises the epiglottis and improves the view If the anterior part of the larynx is still not visible a high note "ee" must be sounded whereby the epiglottis is raised to the utmost and the anterior commissure is brought into view This phonation will show whether the cords adduct normally to the middle line To test abduction the cords should be made to adduct then on drawing a breath the cords abduct to the full extent and if either or both are fixed the position is noted. The most careful manipulation is unpleasant to the patient and it is better to make several short examinations with intervals for rest than to keep the mirror in position too long at one time (Fig 221)

Direct examination of the larynx with a tube spatula is essential for laryngoscopy in small children, and is now generally used for intralaryngeal operations, though these can often be performed by the indirect method

with a mirror The best model is that of Chevalier Jackson which is illuminated by a small lamp at the distal end or the modification of Negus who has introduced a cystoscopic lamp with an optical system which projects the light forward down the larynx and trachea The examination can be made sitting but it is better to have the patient lying on his back with the shoulders raised and the head supported by an assistant or by using a specially moulded block designed to straighten the cervico-dorsal convexity

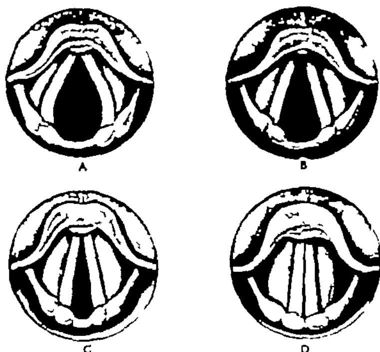


FIG 221

Laryngoscopic views of the normal larynx in (A) deep inspiration, (B) quiet breathing, (C) death and (D) phonation.

(Butterworth.)

of the spine and extend the occipito-atlantal joint Such a support made in several sizes prevents the usual fault of over-extension of the head and neck. A general anaesthetic may be used but is not necessary unless the patient is very intolerant and an injection of scopolamine or hyoscine one hour beforehand is usually sufficient In either case 5 per cent cocaine must be applied to the back of the tongue the epiglottis the lower pharynx and larynx to abolish spasm and reflexes. Cocaine followed by an injection of pentothal is generally an efficient combination. An effective method of cocainisation is to thrust a swab on a long carrier into each pyriform fossa and hold it firmly there for thirty seconds against the superior laryngeal nerve as it perforates the thyrohyoid membrane The area of distribution is soon rendered anaesthetic Cocaine should not be used in children but a general anaesthetic is permissible

The laryngoscope or tube spatula held in the left hand is introduced until the epiglottis comes into view The beak must not be allowed *to go too far* into the deep pharynx otherwise all landmarks are lost but it is passed just over the epiglottis and then tilted so as to pull the epiglottis forwards and

expose the larynx. The right hand is thus left free to use forceps for removal of a small tumour or a piece of tissue for microscopic examination.

For examination of the trachea or bronchus a longer tube passed through the glottis is necessary

In order to protect the air passages from infection by the pharynx and to facilitate the introduction of the bronchoscope through the glottis, Chevalier Jackson first introduces an open laryngeal spatula with the left hand, hooks the larynx well forward then passes the bronchoscope through with the right hand and withdraws the spatula In this way the bronchoscope is introduced without touching the tongue or pharynx but it is possible to insert the bronchoscope in the same way as the laryngoscope The beak is passed between the cords when they separate during inspiration and it may be necessary to wait a few moments for the glottis to open until spasm has passed The most sensitive areas are the posterior wall of the trachea and the carina

Occasionally in the case of real dyspnoea the instrument may have to be pushed carefully through the glottis Secretion should be cleared by a tube attached to a suction apparatus, and the bronchoscope advanced under direct vision only the assistant always holding the head so that the trachea beyond is in line with the bronchoscope Before attempting to pass the instrument into either main bronchus the carina must be identified, again keeping in mind that the right bronchus is the continuation of the trachea and that the left is endoscopically a lateral branch To enter either main bronchus the head of the patient must be moved a little towards the opposite side

To avoid subglottic oedema from pressure on the larynx it is necessary in swinging the bronchoscope to one side to keep the fulcrum at the thoracic aperture and not at the level of the larynx, and in children to avoid using too large a bronchoscope By passing the instrument down the main bronchus the openings of the secondary bronchi can be identified On the right the orifice of the upper lobe bronchus can be recognised but its lumen can only be examined through a retrograde bronchoscopic telescope an instrument fashioned on the principle of the cystoscope and introduced through the bronchoscope

FOREIGN BODIES IN THE LARYNX

A large foreign body impacted in the larynx is likely to cause sudden death from asphyxia but if the opportunity is offered an immediate laryngotomy or tracheotomy would be indicated (Fig 22?)

Small foreign bodies, such as a pin or a nail cause sudden pain, cough and loss of voice Even in this case spasm of the vocal cords may have an immediately fatal effect but it usually soon passes if the foreign body becomes impacted If it moves fresh attacks of spasm are produced and sometimes hæmoptysis If the foreign body is not soon removed inflammatory oedema, perichondritis and abscess may follow though a long period, even years may pass without the development of serious symptoms

Examination by indirect or direct laryngoscopy will usually establish the diagnosis but the assistance of radiography may be required in a suspected case

Treatment —Tracheotomy may be necessary to relieve dyspnoea before removal is undertaken by direct laryngoscopy with straight forceps The need may arise during an attempt at removal

so that the necessary instruments should be ready The foreign body must be firmly grasped in the forceps before any attempt is made to withdraw it otherwise it may slip and fall down into the trachea or a bronchus If this method fails laryngo fissure is indicated

ACUTE LARYNGITIS —Acute inflammation of the larynx commonly follows a head cold, influenza or the specific fevers and is often associated with bronchitis and tracheitis The vocal cords become swollen and injected in severe cases their movements may be impaired and there is transient hoarseness or even complete loss of voice Occasionally submucous hæmorrhages occur which may either *absorb or later organise into* small fibrous tumours The best treatment is rest of the voice and an inhalation of steam containing tinct. benzoini co In children it may cause severe attacks of dyspnœa at night (croup or laryngitis stridulosa) and has then to be distinguished from diphtheritic or membranous laryngitis and from the spasm of laryngismus stridulus which occurs in rickets In this latter condition the voice and breathing are normal between the attacks of dyspnœa, which may be accompanied by tetany (carpo-pedal spasm)



FIG. 222
Bolus of food impacted in the larynx causing sudden death.

A more severe form of acute laryngitis is caused by infection with the *Streptococcus pyogenes* from the teeth, mouth or pharynx. The *onset is often sudden* with symptoms of fever and the mucous membranes become much swollen. The epiglottis and loose tissue of the aryepiglottic folds swell rapidly and dyspnœa is more liable to be caused at this level than by swelling of the cords, so that the term *œdema of the glottis* is misleading Any collection of pus such as a quinsy must be opened and if the breathing is seriously embarrassed tracheotomy performed before the patient becomes exhausted by dyspnœa and general intoxication *either of which may be fatal* Penicillin or other more recent antibiotics should be given in full doses

This type of septic laryngitis occurring in typhoid smallpox, diphtheria, erysipelas or pneumonia may lead to perichondritis The cricoid is the cartilage most liable to be affected but the thyroid and arytenoids do not always escape The inflammation usually ends in

suppuration causing necrosis and exfoliation of the cartilages and the formation of sinuses with much deformity and stenosis of the larynx Pus should be evacuated by incision as soon as it becomes localised and fragments of cartilage removed but the vocal cords are liable to become fixed by ankylosis of the crico-arytenoid joints and tracheotomy is almost inevitable

Chronic perichondritis with similar results is secondary to syphilis tuberculosis or malignant disease especially the last and is sometimes seen in the form of radionecrosis following excessive radiation permanent tracheotomy is required

Membranous laryngitis which occurs in children is usually diphtheritic occasionally streptococcal and rarely due to caustics. The membrane is usually present also in the pharynx but the diagnosis of diphtheria may be difficult if it exists only in the larynx, from which it spreads down the trachea Examination by the direct method is required in this case to establish the diagnosis. If diphtheria is even suspected treatment by antitoxin should be given.

Increasing dyspnœa is an indication for tracheotomy which should not be delayed until the condition of the patient usually a child, is grave

CHRONIC LARYNGITIS

This results from repeated attacks of acute inflammation but important predisposing causes are mouth breathing from nasal obstruction chronic infection of the accessory sinuses of the nose, abuse of the voice combined with faulty production direct irritation, sometimes occupational but commonly from excessive smoking and some general disorders amongst which gout is important

Alteration in the voice may be slight but it is usually hoarse and the singing voice may be lost There is excessive secretion from the larynx and cough. In severe cases with pronounced local changes the diagnosis may have to be made from tuberculosis syphilis and malignant disease Hyperæmia and hyperplasia are rarely unilateral, as in the early stages of those diseases In a localised form the changes may occur at the junction of the anterior and middle thirds of the cords as singer s nodules " These are seen chiefly in female singers and school teachers and are best treated by lessons in voice production so that abnormal strains on the cords from forcing the voice are eliminated.

Atrophic laryngitis in which the larynx is lined with foul green crusts is almost invariably secondary to atrophic rhinitis (ozæna) but it may occur primarily and even spread down the trachea.

Pachydermia of the larynx is localised to the vocal processes where the papillæ increase and outgrowths of highly keratinised epithelium project The outgrowth on one side commonly fits into a corresponding depression on the summit of the opposite one so that the cords can almost meet in spite of these excrescences Gout is often associated with the pachydermia

TUBERCULOSIS OF THE LARYNX

This is so rarely primary that it should always be regarded as a complication of phthisis The first manifestation may be laryngeal but unless the disease is arrested the pulmonary lesion will soon be revealed by physical signs or by the presence of tubercle bacilli in the sputum When in doubt radiography may reveal the primary lesion in the lung before physical signs appear

In most cases the larynx becomes infected from the sputum either through slight abrasions or possibly the unbroken mucous membrane but a persistent laryngeal catarrh is frequently the forerunner of a definite deposit of tubercle

The bacilli thus reach the lymphatics where the disease starts and whence it spreads in the larynx There is therefore a predilection for the disease to attack the neighbourhood of the posterior commissure the part most richly supplied with lymphatics and in some cases the path of infection from the lung to the larynx may be by the lymphatics

In the last twenty years the disease has diminished in frequency both absolutely and in relation to pulmonary tuberculosis by about one half This is shown both from clinical records of early cases and by post mortem observation on cases of phthisis It occurs now in about 5 per cent of early and about 30 per cent of advanced cases The age incidence corresponds to that of phthisis but senile tuberculosis of the larynx is not uncommon and may be mistaken for malignant disease Sex has no influence and the old view that it is commoner in males is no longer correct

Localised patches of anæmia or hyperæmia in the larynx and chronic laryngitis which are not tuberculous are frequent in sufferers from phthisis and may open the path to true tuberculous infection

In early cases the interarytenoid fold is most commonly attacked in the form of a deposit, which may be raised into a peak by the compression of the arytenoids during phonation or of an irregular indolent ulcer The posterior laryngeal wall immediately above and behind the vocal process of the arytenoid is also a frequent site for the deposit of early tubercle Such a lesion may be unilateral or more advanced on one side The central and posterior thirds of the vocal cords are the next most frequent sites The cord becomes pink, loses its lustre and tension, and an indolent shallow ulcer appears A more extensive stage of this ulceration produces a mouse-nibbled appearance of the vocal cords. These are the three areas commonly affected early Much more rarely the epiglottis the aryepiglottic folds and the ventricular bands may be the primary site in the larynx the incidence being about equal among these areas. The cases thus tend to fall into an intrinsic and an extrinsic group At this stage which is favourable for treatment there may be no local symptoms or only a husky voice In the more advanced stage of the disease the extrinsic parts of the larynx show a pale translucent swelling of the *mucous* membrane The surface over the arytenoids and the *aryepiglottic* folds become pyriform on one or both sides. The swelling of the epiglottis is described as turban-shaped and it may hide the *interior*

of the larynx from view. Finally deep ulceration may cause destruction of the epiglottis and perichondritis of the arytenoid cartilages, or rarely of the thyroid or cricoid.

This perichondritis is occasionally localised to the neighbourhood of a crico-arytenoid joint which becomes ankylosed with fixation of the corresponding vocal cord.

In the later stages pain and difficulty in swallowing are the most serious symptoms accompanied by cough and expectoration. The voice becomes weak and husky, but functional loss of voice is rather a symptom of phthisis and occurs without local changes in the larynx. Dyspnœa is rare but subglottic œdema, extensive supraglottic swelling or perichondritis occasionally call for tracheotomy.

The *diagnosis* has to be made from syphilis intrinsic cancer and occasionally from pachydermia. Rarely aspergillosis causes an ulceration around the glottis indistinguishable in appearance from tuberculosis.

In early cases the *prognosis* is now less unfavourable than in the last century when the disease was almost invariably fatal. Recovery is now possible in over 30 per cent. of cases but the outlook depends largely on the condition of the lungs. Advanced cases are still almost hopeless.

Treatment.—Rest to the larynx by maintaining absolute silence is the sheet anchor in treatment and can be followed only in a sanatorium. Recently streptomycin given parenterally has produced good results as far as the laryngeal lesion is concerned but its effect on the pulmonary lesion is disappointing especially where there is cavitation. The older methods of local treatment including applications of the electric cautery and amputation of the epiglottis will probably fall into further disuse. In advanced cases a linctus of morphia or heroin is necessary for the cough and lozenges or insufflations of orthoform or anæsthesin to relieve painful ulcerations. Applications of cocaine or alcohol injections of the superior laryngeal nerve will alleviate dysphagia but tube feeding may be necessary.

SYPHILIS OF THE LARYNX

Primary sores are reported to have been observed on the edge of the epiglottis and even on the left false cord but in such unusual situations the disease is not likely to be recognised before the appearance of secondary manifestations.

Secondary syphilis commonly shows itself in the larynx as an erythema. The vocal cords have a mottled appearance. Mucous patches on the epiglottis aryepiglottic folds or vocal cords are less common appear later and are evanescent. They may be followed by superficial ulceration which is a rare and a late manifestation of the secondary stage. The only local treatment required is an inhalation of benzoin vapour.

In the *tertiary stage* laryngeal syphilis may have very serious effects. (1) A diffuse gummatous infiltration may affect the epiglottis the arytenoid eminences or the false cords. The colour is deep red or

purple with sometimes a yellow spot which indicates an area of softening A circumscribed gumma appearing as a definite tumour in the same situations is rare and multiple nodular gummata rarer still (2) The commonest manifestation of tertiary syphilis is deep ulceration supervening on a gumma The ulcer takes the form of a crater with sharp punched out edges and a congested areola The base is grey and sloughy (3) Gummatous perichondritis attacks the thyroid cartilage chiefly causing much swelling inside the larynx and narrowing of the glottis with dyspnoea Any of the other cartilages may be attacked with the formation and exfoliation of a sequestrum (4) The larynx may be much distorted by scars and adhesions after healing The epiglottis may be destroyed and the vocal cords united by cicatricial webs There may be subglottic stenosis or stenosis of the trachea and the crico-arytenoid joints may become ankylosed.

The *symptoms* correspond to the various pathological conditions There may be only hoarseness but the voice is strong and raucous. Ulceration of the extrinsic regions causes pain and dysphagia. Stenosis causes dyspnoea and stridor worse at night The insidious progress of the stenosis allows the patient to become gradually accustomed to it so that no distress is caused.

The *diagnosis* may have to be made from tuberculosis and malignant disease Tertiary syphilis affecting a vocal cord may be indistinguishable in appearance from a carcinoma.

Examination of the chest and sputum the Wassermann test and sometimes removal of a piece for microscopic examination may be employed, but the Wassermann test is often negative in this form of tertiary syphilis

General treatment is essential and penicillin has now replaced the older methods of treatment with arsenical preparations bismuth and potassium iodide Tracheotomy may be necessary to relieve dyspnoea from increasing stenosis of the glottis but the need may sometimes be averted by prompt antisyphilitic treatment if the patient is kept in bed The stenosis does not respond well to dilatation and the tracheotomy cannula may have to be worn permanently if antisyphilitic treatment does not prove effective

PARALYSIS OF THE LARYNX

The laryngeal muscles act as (*a*) adductors (*b*) abductors and (*c*) tensors of the vocal cords. In addition, the thyro-epiglottidean and aryteno-epiglottidean muscles act as sphincters of the larynx

Negus summarises the positions of the vocal cords as follows —

1 Extreme abduction produced by deep inspiration (Fig. 221 A)
2 Moderate abduction in quiet respiration (Fig 221 B)
3 The median position in which the cords lie in the midline seen during phonation (Fig 221 D)
4 The paramedian position in which the cords are very slightly abducted from the midline (Fig 223) This position is assumed in a strong whisper and is taken up by the cords in complete paralysis of the recurrent laryngeal nerve

5 After death or when *all* muscles of the larynx are paralysed the slack cords lie in a position between that of moderate abduction and the paramedian position which is known as the cadaveric position (Fig 221 c)

The nerve supply of the laryngeal muscles is the recurrent laryngeal, except the cricothyroid a tensor of the cords supplied by a branch of the superior laryngeal which is also the sensory nerve of the larynx.

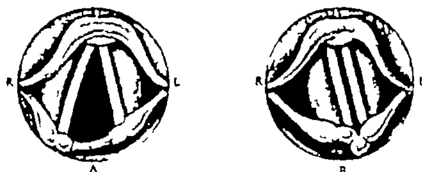


FIG. 223

Complete paralysis of the left recurrent nerve Position of the vocal cords on (A) inspiration and (B) phonation.

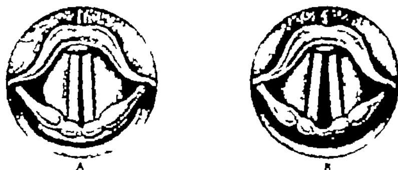


FIG 224

Double abductor paralysis. Position of the vocal cords on (A) inspiration and (B) forced expiration.

Although the recurrent laryngeal nerves supply both the abductors and adductors pressure or progressive lesions of the trunk or bulbar centre of the nerve produce firstly abductor paralysis The internal tensors and the arytenoideus are affected next and the adductors last (Semon's law) The cortical centres act bilaterally so that laryngeal paralysis unless functional is not produced by cortical lesions. A lesion in the bulb may produce a unilateral or bilateral abductor or total paralysis (Figs 223 and 224)

Adductor paralysis or functional aphonia is usually seen in young women The crico-arytenoidei laterales and the arytenoideus are the muscles concerned and there is usually also a paralysis of the tensors—the thyro-arytenoidei. The condition sometimes accompanies or follows an attack of acute laryngitis It is important to remember that this

functional paralysis is sometimes the earliest symptom of pulmonary tuberculosis

Although the patient is unable to phonate she can cough naturally On examination the cords may make no attempt to approximate they may move towards the middle line but fail to meet or they may meet but immediately fly apart without the production of any sound The edges of the cords are usually concave from paralysis of the tensors

General *treatment* is more important than local The aid of the psychiatrist is usually required to rectify the underlying psychological disturbance Anæmia must receive treatment Strychnine is useful Electricity applied locally usually has only a temporary effect Lessons in voice production and proper breathing are necessary to obtain permanent cure

Paralysis of the cricothyroid muscles the external tensors of the larynx is rare and usually results from diphtheria. If the whole superior laryngeal nerve is affected it may be accompanied by anæsthesia of the larynx In addition to hoarseness and weakness of the voice therefore there may be coughing and choking from food entering the larynx

The cords are slack and have an irregular outline or the affected cord may be at a higher level than the other in unilateral paralysis The treatment must be directed to the relief of any lesion of the superior laryngeal and, if necessary to preventing food entering the larynx by employing tube feeding

Bilateral paralysis of the abductor muscles the crico-arytenoidei postici may be central from tabes bulbar paralysis or syringobulbia. Bulbar paralysis however is more likely to produce paralysis of the tongue and hyoid muscles and abductor paralysis of the cords is rare In the course of the vagus or recurrent nerves pressure may be produced by aneurysms cancer of the œsophagus enlarged lymphatic glands malignant or even simple goitre and cut throat or goitre operations may also produce abductor paralysis It may follow a thyroid operation after an interval of several weeks Peripheral or toxic causes are typhoid fever influenza, diphtheria rheumatic fever pneumonia, scarlet fever and lead poisoning Myopathic paralysis is generally due to direct extension of local disease such as carcinoma of the lower pharynx. It may be simulated by ankylosis of the crico-arytenoid joints following a rheumatic arthritis or periarticular cicatrisation

In progressive lesions the diminished power of abduction is first shown by the inability of the cords to separate fully on deep inspiration When all power of abduction is lost the cords remain in or near the middle line owing to contracture of the unopposed adductors This is described as the chink position because of the gap between the cords which results from the loss of the backward bracing action of the posticus muscle on the arytenoids This allows gentle respiration but inspiratory stridor may occur if the cords become sucked towards the middle line The cords are blown slightly apart during expiration (Fig 224 A and B) The voice is usually unaffected and the chief symptom is increasing dyspnœa worse on exertion and at night In

tabetica laryngeal crises take the form of adductor spasm apart from abductor paralysis.

Treatment.—If the attacks of dyspnœa cause distress or threaten suffocation tracheotomy is necessary. The use of a flap valve in the tracheotomy tube allows the patient to speak. Preferably, however, Woodman's modification of an extralaryngeal arytenoidectomy can be used to relieve the dyspnœa with the retention of a fair voice. In this operation the posterior part of the upper half of the thyroid ala is removed and the arytenoid cartilage extracted by submucous dissection. A suture passing through the posterior end of the vocal cord and round the inferior cornu of the thyroid cartilage fixes the cord in the position of abduction. A tracheotomy is required until one week after the operation. It should be remembered that the lesion causing the paralysis may also cause dyspnœa from direct pressure on the trachea.

In unilateral abductor paralysis the causes are similar. In tabes, for example, the paralysis may be bilateral or unilateral, but as the left recurrent nerve turns round the aorta it is more likely to be stretched by an aortic aneurysm. Paralysis of the right cord is most commonly caused by a tuberculous lesion at the apex of the right lung, rarely from an innominate or subclavian aneurysm. At first the outward movement of the cord is defective, but later it becomes fixed near the middle line. The voice is not affected and treatment must be directed to the cause. Tracheotomy is not required as there is no dyspnœa except occasionally on exertion.

In complete recurrent laryngeal paralysis one or both sides of the larynx may be affected. The bilateral condition is rare, but complete paralysis of one cord with abductor paralysis of the other is often seen. Complete paralysis is a further stage of abductor paralysis following Semon's law. The affected cord is motionless in the cadaveric position with its edge concave from paralysis of the tensors.

The arytenoid cartilage is tilted forwards, which makes the cartilage of Wrisberg very prominent, and it may be mistaken for an inflammatory swelling or tumour. On phonation the healthy cord which is taut and active crosses the middle line to approximate with the paralysed cord. The cartilage of Wrisberg is seen to move forward in front of the one on the paralysed side. The whole larynx in consequence looks asymmetrical and is sometimes thought to be tilted to the sound side. In the rare bilateral cases both cords are concave and lie motionless in the paramedian position. In unilateral cases there may be hoarseness until the sound cord has adapted itself to cross the middle line and come into apposition with the paralysed cord. In bilateral cases phonation is lost entirely, and if in addition the thyro-epiglottidean and aryepiglottidean sphincters of the larynx are paralysed, there may be coughing and choking from food and drink entering the larynx and trachea.

A number of associated paralyses are described in which the last four cranial nerves are concerned. A variety of syndromes can thus occur of which the best known is that of Hughlings Jackson. In this there is associated paralysis of the larynx, palate, tongue and the sternomastoid with the trapezius, which indicates the presence of

an intracranial lesion or one near the point of exit from the cranium of the vagus, spinal accessory and hypoglossal nerves It is more important to classify these syndromes according to the level of the lesion causing the paralyses than by names The most important situation is at the level of the jugular foramen where the ninth tenth eleventh twelfth and sympathetic may all be involved The last is shown by narrowing of the pupil and enophthalmos (Horner s Syndrome)

TUMOURS OF THE LARYNX

Innocent Tumours of the larynx are comparatively rare The most common are papilloma and fibroma, the latter originating sometimes from the organising clot of a submucous hæmorrhage Lipoma angioma chondroma adenoma and myxoma are very rare

PAPILLOMA (Fig 225) is usually single but in children may be multiple The growths are then situated on the cords and ventricular bands, and sometimes extend below the cords and even to the trachea but not upwards to the epiglottis The growth is warty and varies in colour from white to pink and red and is usually but not invariably pedunculated A single growth may attain large size in an adult Hoarseness is the only symptom unless the tumour is large or multiple when dyspnœa and stridor may result FIBROMA is always single and is generally attached to the upper surface of the middle or anterior third of the vocal cord



FIG. 225
Papilloma of the larynx in a child.

ANGIOMA occurs on the cords and also on any part of the mucosa in the neighbourhood It is an occasional cause of hæmoptysis

Innocent growths are best removed with laryngeal forceps by the direct method using an endoscopic tube In children dyspnœa may call for tracheotomy after which papillomatous tumours sometimes disappear spontaneously Chondroma or lipoma may also call for this before removal by laryngo-fissure Angioma may be treated by the electric cautery to check hæmorrhage but will require for its removal laryngofissure or very rarely lateral pharyngotomy depending on the situation Irradiation by X-rays is sometimes used for the treatment of multiple papillomata, but care must be taken to avoid the danger of cartilaginous radio-necrosis especially in children

Malignant Tumours of the larynx are relatively uncommon, as they only account for about 2 per cent of the total incidence of cancer They are ten times more common in men than in women, but the etiology

is unknown though smoking is considered by some to be a predisposing cause They occur usually at the same period of life as elsewhere in the body but are occasionally seen in quite young people

Squamous-celled carcinoma is far more common than any other variety but basal-celled carcinoma occurs in 2 per cent of cases while papillary carcinoma and adenocarcinoma are still more rare Sarcoma and hæmangio-endothelioma are also rarely encountered Metastatic deposits are extremely rare but hypernephroma has been observed in the larynx. Laryngeal growths only rarely cause metastatic tumours in other organs



Fig. 226

Laryngoscopic appearance of an intrinsic carcinoma of the larynx.

Malignant tumours of the larynx were classified by Krishaber into intrinsic and extrinsic

(*a*) Intrinsic tumours arise from the vocal cords the ventricles and the ventricular bands

(*b*) Subglottic tumours though intrinsic in situation present special clinical features

(*c*) Extrinsic tumours which arise on the epiglottis aryepiglottic folds and in the pyriform sinus are from a pathological and surgical standpoint pharyngeal tumours

(*d*) Mixed tumours may be either extrinsic or intrinsic in origin, but in an advanced stage occupy both situations

INTRINSIC CARCINOMA especially the common form which arises on the anterior portion of a vocal cord and spreads slowly along the cord takes long to invade the cervical lymphatic glands the vocal cords possessing few lymphatic vessels (Figs 226 and 227)

EXTRINSIC CARCINOMA runs a more rapid course invades the lymphatic glands early and is far more difficult to cure by excision (Fig 228)

A INTRINSIC CARCINOMA.—The only *symptom* in its early stage is hoarseness There is no pain cough or dyspnœa until the later stages when the growth spreads across to the opposite cord at or often below the anterior commissure In a still later stage the voice is reduced to a harsh whisper the growth becomes extrinsic and may produce perichondritis with dysphagia salivation and general signs of cachexia.



Fig 227

Specimen showing an intrinsic carcinoma of the larynx.

The *diagnosis* has to be made from simple tumours chronic

laryngitis and especially from tuberculosis and syphilis Fixation of the cord is an important sign in favour of malignant disease but it is important to remember that the cord remains mobile in the early stages and that fixation indicates that infiltration has begun The patient should be examined for signs of pulmonary tuberculosis by auscultation radiography and testing the sputum and for syphilis by the anamnesis and by blood tests A chronic fibrotic form of tuberculosis often simulates carcinoma, so that it is frequently necessary to remove a portion of growth with forceps for microscopic examination to make certain of the diagnosis

Treatment —In the early stages the growth may be excised by laryngofissure or occasionally if it is confined to the anterior part of both cords by removing the front of the thyroid cartilage with the underlying growth However improvements in the technique of radiotherapy give results as judged by a five-year cure equal to those obtained by laryngofissure and anterior hemilaryngectomy and the voice is usually better than after operation so that many authorities regard irradiation as the method of choice in these cases.

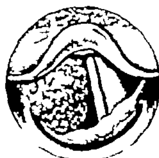


FIG. 228

Laryngoscopic appearance of an extrinsic carcinoma of the larynx

B In SUBGLOTTIC CANCER hoarseness is not necessarily the earliest symptom, but the patient complains more of symptoms of laryngeal catarrh and the disease may progress insidiously in this way until stridor develops It is particularly apt to spread through the cricothyroid membrane and to invade the gland of Poirier It occasionally produces paresis of one vocal cord of obscure origin Such cases are rarely suitable for laryngofissure or irradiation and total excision of the larynx is usually necessary

C EXTRINSIC CANCER, usually on the epiglottis aryepiglottic fold or on the lateral wall of the pharynx with extension to the aryepiglottic fold at first produces only local discomfort which increases to pain radiating to the jaw and ear and aggravated by swallowing Pain in the ear may for months remain the only symptom or the first sign be the appearance of a hard gland in the neck. The voice acquires a characteristic muffled quality without actual hoarseness especially if the growth is pedunculated and projects into the pharynx The progress is rapid with a steady increase of pain salivation and dysphagia and the development of a fixed mass of malignant glands in the neck.

The use of the laryngoscope is essential for diagnosis and if the nature of the disease is suspected the diagnosis is simple

In women a particular type of carcinoma appears in the pharynx, in the mucosa on the back of the cricoid plate long causing the one symptom of dysphagia and sometimes associated with the Plummer Vinson syndrome (p 440) As it grows this type of tumour tends to encircle the lumen of the oesophagus and then break through

into the groove between the trachea and oesophagus, where it attack the recurrent laryngeal nerve and the posterior border of the lateral lob of the thyroid gland The upper edge may be visible in the mirror o sometimes only an area of congestion is seen on the back of the laryn above the growth In men a pool of mucopus at the entrance may b the only physical sign of a growth starting in the pyriform sinus below

For this group of tumours if seen early the treatment is excisio by lateral pharyngotomy combined with dissection of the cervica glands Irradiation by X rays can cause the tumour to disappear bu usually the improvement is temporary and this treatment apparentl may produce a general dissemination which otherwise is rare

D In the mixed form the disease is usually inoperable but pharyngolaryngectomy is occasionally successful Tracheotomy ma be performed for the relief of dyspnoea in cases otherwise inoperabl but the results are disappointing and the growth is apt to invade th tracheal aperture and to reach the skin surface

OPERATIONS ON THE LARYNX AND PHARYNX

LARYNGOTOMY —A temporary opening for respiration is made throug the cricothyroid membrane in cases of sudden and urgent larynge obstruction. Tracheotomy or the peroral introduction of an intratrache tube has entirely replaced laryngotomy as a m thod of delivering a *anaesthetic in operations on the upper air passages*

TRACHEOTOMY —Laryngeal obstruction calls for relief of the dyspnoe by tracheotomy Such indications as injuries tumours inflammator stenoses from syphilis and diphtheria have already been outlined. *It is* al indicated as a preliminary to the operation of lateral pharyngotomy t facilitate administration of the anaesthetic maintain the air way durin the manipulation of the larynx and exclude blood from the lower air passag by packing the larynx and lower pharynx

An opening into the trachea above the isthmus of the thyroid gland which covers the 3rd and 4th rings is called a high tracheotomy and one below is a low tracheotomy In practice, however this distinction is not now maintained because the thyroid isthmus should always be divided if possible and a median tracheotomy performed. Otherwise if the tracheotomy tube slips out, the isthmus may cover the opening and prevent *the tube* from being re-inserted before the patient is asphyxiated For a child with diphtheria however a high tracheotomy is indicated, while a tracheotomy for malignant disease should be placed as low as possible In adults local anaesthesia *by infiltrating with* 2 per cent. novocain and a *few drops of* adrenalin should always be *employed* especially if there is stridor In children chloroform slowly administered is safe but the anaesthesia must be light so that there is no sudden increase of dyspnoea or cyanosis.

The patient lies on the back with a support under the shoulders so that the neck is extended but if stridor is present it is to be remembered that the neck cannot be fully extended without increasing the dyspnoea. The extension draws the trachea up from the thorax and projects it forwards. The point of the chin and the suprasternal notch are to be kept carefully in the middle line The skin platysma and superficial fascia are divided by a vertical median incision from the lower border of the cricoid cartilage downwards. The anterior jugular veins running either side of the midline should be identified and drawn aside with retractors The two layers of the superficial division of the deep cervical fascia are then divided, and the

pre-tracheal muscles identified and retracted The trachea is exposed by blunt dissection and the isthmus of the thyroid gland drawn down or divided between clamps. The trachea is then steadied with a hook, if the patient is a child and incised in the middle line The edges are held apart with a dilator and the warmed tube introduced If the patient is an adult it is better to cut an opening in the front of the trachea to fit the tube for in this way pressure necrosis of the tracheal cartilages is avoided The insertion of the tube produces a bout of coughing which may be prevented by instilling a few drops of 2 per cent. cocaine with a hypodermic syringe between two rings before the trachea is opened if there is no urgency and no risk of blood entering the trachea In the low operation the inferior thyroid plexus of veins must be avoided.

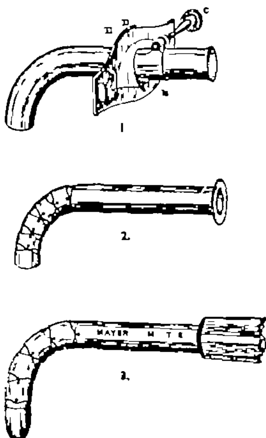


Fig 220

Durham tracheotomy tube showing its component parts. (*Mayer & Phelps.*)

1. Outer tube. 2. Inner tube 3. Pilot.

Points of special importance are to keep strictly in the middle line and to open the trachea in the midline If the trachea be drawn to one side it may be missed and a wound inflicted in the œsophagus, the common carotid artery or the vertebral column. The pre-tracheal fascia must be well cleared so that the tube is not inserted between it and the trachea The opening must be in the front and not to one side of the trachea, or the tube will not be comfortably in it. The cricoid cartilage must not be injured in children, or sub-glottic laryngeal stenosis will result

For most purposes, Durham's tracheotomy tubes with a lobster tailed inner tube and pilot serve best (Fig 220) The outer tube should always be inserted with a pilot, which should be kept at hand in case the former slips and needs to be re-inserted To insert the tube the pilot should be held at right angles to the neck, and as the tube is inserted it is rotated towards the middle line and raised

In diphtheria the tube should be removed as soon as possible after the emergency has passed, but if a permanent tracheotomy is designed the outer tube should be left in position for at least ten days to make a track before being removed The inner tube may be taken out for cleaning as often as desired

When a patient sits up and brings the head forward the trachea slips down and away from the surface so that a greater length of tube is required.

and the shield may need adjustment to fit comfortably against the skin. If the tube has to be re inserted the head of the patient must be extended to bring the trachea forward and out of the thorax otherwise it may be impossible to find the opening When a tube is to be removed and not replaced it is advisable to do this in the morning rather than in the evening, because dyspnoea is always greater at night

LARYNGOFISSURE AND PARTIAL LARYNGECTOMY —The removal of a tumour usually malignant is almost the only indication for laryngofissure, but it is occasionally performed for localised tuberculosis, the removal of foreign bodies and the relief of rare forms of laryngeal stenosis. Under local infiltration or chloroform anaesthesia a preliminary tracheotomy is performed. The thyroid cartilage is divided in the middle line and the cricothyroid membrane opened. The inner perichondrium of the cartilage is raised by blunt dissection and the whole length of the vocal cord removed

When the neoplasm occupies the anterior commissure the operation may be modified by dividing the thyroid cartilage on either side of the middle line and removing the anterior portions of both cords with the over lying piece of cartilage The larynx heals without any stenosis sufficient to cause symptoms, and the patient preserves a useful voice.

TOTAL LARYNGECTOMY —In cases of intrinsic carcinoma too advanced for removal by the above operations total excision of the larynx is required. A large flap of skin the base of which is at the level of the hyoid bone, is turned upwards The larynx is freed from its external connections, and the pharynx is opened laterally The pharyngeal mucous membrane is divided round the entrance to the larynx and dissected out of each pyriform fossa. The epiglottis should always be removed with the larynx. Where the growth has involved the region of the stalk of the epiglottis the hyoid bone should be removed with the larynx owing to the likelihood of neoplastic involvement of the tissues in the pre-epiglottic space which is bounded in front by the thyrohyoid ligament behind by the attachment of the epiglottis and above by the hyo-epiglottic membrane A feeding tube is inserted and the pharynx closed with catgut sutures and stitched to the base of the tongue The skin flap is sutured to the edge of the trachea and the rest of the wound closed with ample lateral drainage Pharyngolaryngectomy is a modification of this operation in which a part of the pharynx is removed with the larynx. The gap in the pharynx is closed at a later plastic operation

LATERAL PHARYNGOTOMY —The excision of tumours on the epiglottis, the aryepiglottic folds and the post-cricoid region requires two distinct steps First an anatomical dissection to expose the tumour and second, its removal with a margin of at least half an inch of surrounding tissue Access to the pharynx is provided by removing the ala of the thyroid cartilage and the great cornu of the hyoid bone The tumour is excised and the cut margins of the pharynx are sutured to the skin. Perfect drainage is thus obtained, and the risk of bronchopneumonia is small. The pharyngostome must be closed by a plastic operation later

The principal risks in these operations arise from streptococcal infection from the pharynx and from sloughing These are minimised by dental extractions at least ten days prior to operation and by pre-operational and post operational systemic disinfection by penicillin.

Tube feeding demands a fluid diet of high caloric value together with an adequate vitamin content The following is used at St Mary's Hospital —

30 oz water
[illegible] oz full cream dried milk powder
4 oz sugar or glucose
2 oz dried egg powder

The mixture may be warmed to blood heat but never boiled and given in eight 5-oz. feeds

It should be supplemented by —

200 mg ascorbic acid
30 gr ferri ammon. cit
One tablet Benerva Co
Five drops of radiostoleum

J F Simpson

CHAPTER XXIV

THE CHEST

PHYSIO MECHANICS—The thorax may be regarded as a cone whose walls—the ribs sternum and spine—are semi rigid, and whose base—the diaphragm—is soft and mobile Respiratory movements are carried out from the spine by the movement of the ribs, forwards, outwards and upwards on inspiration The upper part of the chest moves mainly upwards but more effective movement is chiefly at the base of the lungs where the lateral rib expansion and the powerful downward action of the diaphragm enormously increase the content of the thorax. The diaphragmatic sheet at rest is domed upwards into the chest leaving deep costophrenic sinuses at the periphery and on inspiration the muscular contraction depresses the dome and exerts pressure on the abdominal contents. Inspiration is an active process enlarging all diameters, while ordinary expiration is a passive relaxation reducing the total volume of the chest.

The thoracic contents consist of the two lungs each with its separate pleural sac separated by the mediastinum Each lung is held out to the chest wall by the subatmospheric pressure or suction of the pleural cavity This works against its natural elastic tendency to retract towards the root. This tension on each side is normally balanced against the mediastinum, which though mobile remains central Any upset of this balance displaces the mediastinum with adverse clinical effects. The mediastinum can be pushed over by the presence of air (pneumothorax) effusion (hydrothorax), pus (pyothorax) or blood (hemothorax) and if this pressure effect is variable as in open pneumothorax the mediastinum will move backwards and forwards—mediastinal flutter—with severe perturbation of the respiratory and circulatory functions The mediastinum can also be pulled out of position by active collapse of lung (atelectasis) or by fibrosis due to disease

Owing to the soft retractile nature of the lung considerable pressure effects can be sustained without producing symptoms so long as they develop slowly Sudden pressure leads to more dramatic results.

Deformities—Abnormalities of the thoracic cage are common but rarely important clinically Bifid ribs, particularly the anterior ends of ribs 3 or 4 are common A "funnel" chest due to absence of the lowest part of the sternum consists of the costal cartilages buckling in on the midline. If severe the heart may be displaced to the left "Pigeon" chest with marked protuberance of the lower sternal region has the lower costal cartilages angled forwards. Apart from the appearance there is rarely any need for surgery Some cases of funnel chest can be treated by mobilising the depressed area and using traction to keep it elevated.

Scoliosis due to congenital deformity of the spine (maldevelopment of one-half of a vertebra) is severe but there are numerous other causes posture inflammation of pleura and lung which vary considerably in degree.

INJURIES

The relatively large volume of the thorax makes it inevitable that a high proportion of major injuries to the body will involve the chest and its contents but as the shoulder girdle and arms in the upper part and the abdomen in the lower are in such close contact it is common to find injuries to the thorax complicated or associated with other forms of damage

Injuries as a whole may be divided into two groups —

1 Non penetrating or crush injuries
2 Penetrating wounds such as are commonly seen in gunshot or shell fragment lesions.

Non Penetrating or Crush Injuries

The severity of the damage to the chest and its contents depends on —

(a) The force of the injury
(b) The direction of lines of force
(c) The age of the patient since in young children the ribs are more supple and have more give in them than in the case of the brittle ribs of an aged person

The extremes of injury may be instanced by the fracture of a rib as the result of a sharp blow from a kick on the chest and at the other extreme a crush of the body between buffers or falling from a great height or a crash in an aeroplane accident

In the case of a fractured rib there may be only local contusion with a hæmatoma round the fractured ends of the broken bone though if a spike of bone is driven inwards it may puncture lung and produce a pneumothorax. More gross or heavy forms of injury may result in severe damage to the lungs and structures within the mediastinum, and may possibly be accompanied by rupture of the liver or spleen

Diagnosis —In any case of chest injury the three main conditions to be looked for are (a) shock, (b) hæmorrhage and (c) escape of air from lung into the pleura (pneumothorax) or subcutaneous tissues (surgical emphysema)

The varying degrees of shock should improve under appropriate treatment Hæmorrhage on the other hand may reach large proportions particularly when the intercostal and internal mammary arteries are ruptured, assuming that no greater vessel has been torn The bleeding into the pleural sac may be steady and prolonged, reaching several pints in volume and should always be suspected when shock does not readily improve Signs of a pleural effusion may present and the pressure of blood can be confirmed with the aspirating needle and at the same time if the lung or air tubes are damaged there will be blood-stained sputum

Another important factor is the presence of air within the pleural cavity producing a pneumothorax due to admission of air from outside or to rupture of lung surface with escape of air into the pleura This leak increases considerably with each effort at coughing but if the pneumothorax is not of large size the lung simply collapses without

be taken is against the administration of anæsthetics at a time when a large amount of lung tissue has been put out of action This precaution must be insisted upon for unless rapidly fatal the condition will gradually resolve spontaneously and the mottling seen in the radiogram will disappear in about a fortnight The type of injury seen after aeroplane crashes is not dissimilar and the high impact produces hæmatoma and effusions throughout the lung associated with severe generalised disturbance which if not fatal takes rather longer to resolve The administration of oxygen warmth morphia and careful intravenous therapy have all to be considered in the early stages.

Penetrating Wounds

Penetrating wounds of the thorax have been familiar to surgeons since the days of the arrow sword and lance to the present war-time conditions where the injuries are more commonly due to bullet shell fragments of all sizes and other missiles Of all the fatalities on the field of battle it will be found that chest wounds are present in probably a third or more but only a very small proportion of those wounded in the chest are available for treatment A high death rate is to be expected in view of the likelihood of damage to the heart or great vessels in the thorax and to the association of injury with other parts of the body The type of injury that comes for treatment varies from a relatively simple bullet wound in the outer part of the chest in the middle third to the massive laceration produced by bomb or shell fragments where structures closer to the mediastinum or in the upper or lower part of the chest are involved The clean drilling of a bullet is naturally less damaging than the spinning laceration of a jagged missile and the least fatal site is in the mid third of the chest rather than in the upper part where the structures in the base of the neck may be involved or in the lower part where the abdominal contents may also be injured.

The division of penetrating injuries into open and closed" is important A closed injury in which the missile track has been sealed off by clot and retraction of tissues creates a condition similar to that in non penetrating wounds When the wound is open on the other hand air can enter and leave the pleural cavity and a sucking wound presents Tension within the pleural cavity may be rapidly added to the distress of an ordinary pneumothorax and if a wide open wound persists in the presence of internal injury a mortality of 90 per cent is to be anticipated. Consequently the first stage in treatment of any penetrating wound of the chest is to ensure that the external opening is closed, and the entry of air into the pleural cavity prevented

Closed Wounds.—Closed wounds as has been said resemble the simpler forms of non penetrating injury and where the bullet has passed through the chest without exploding against rib or spine there is a cleanly drilled hole in the lung and the small escape of air produces a pneumothorax of minimal character If however the larger lung vessels or chest wall vessels are torn particularly when rib is fractured a hæmothorax is inevitable but it is unusual for infection to follow in such cases.

The missile may be retained, and the position is usually determined by its striking the far side of the chest wall and rebounding for a short distance into lung The ribs the vertebral column and even the mediastinum behave as solid structures for the rebound

Treatment —Treatment consists in a routine measure of warmth morphia and oxygen Transfusions are often necessary and the use of chemotherapy as a protection against infection is adopted as a routine for some days Radiological examination may demonstrate presence of the wound track through lung in addition to any associated fluid or air within the pleural cavity and it will also reveal fracture or otherwise of rib which has some importance since exploded or fractured bone is likely to be more damaging to the chest contents than where the inter costal space has been cleanly drilled. It is not practicable to excise a wound track which has completely traversed the chest but where there is a grossly contaminated superficial wound excision must be carried down as far as the pleura other layers must be carefully sutured but the skin only loosely closed and penicillin dusted into and over the wound.

Lacerated and Sucking Wounds.—As has been indicated where there is an open or sucking pneumothorax shock and distress are always severe and require urgent and immediate measures for their relief The jagged torn edges of the wound are covered by a frothy mass of blood. The patient is cyanosed and distressed, making ineffectual efforts to cough with bloody mucus in the mouth and expectoration The general measures of shock treatment are adopted and the first step that has to be taken is closure of the sucking wound. There is usually a partial attempt at closure from torn muscl and clot but as an immediate measure a firm dressing sh o prevent further ingress of air to the pleural cavity

The importance of obtaining an airtight closure vaseline gauze oilskin and adhesive are all possible mean admission of air Rapid improvement will follow the open pneumothorax and its conversion into a closed o shock symptoms have abated more formal attempts a be carried out A lacerated wound is excised in all its the chest wall and fragments of indriven bone cloth removed, but a formal thoracotomy and exploration cavity need only be taken where there are continued signs o or obvious damage to the lung

During the recent war it was found that modified ex ment as described, rather than extensive and early for produced more satisfactory and certainly safer results process of cleaning up the pleural cavity can be sucked and the chest wall layers closed again so as to make the ori quite airtight If any drainage of the pleural cavity is mu t be of the water-seal closed drainage type but it is inde avoid any form of drainage and to depend on repeated and in a pirations to remove blood and fluid from the pleural cavity the pleural cavity is aspirated penicillin (100 000 to 250 000 u injected at the end of each procedure Infection may superve

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The importance of obtaining an airtight closure is obvious and vaseline gauze oilskin and adhesive are all possible measures of preventing admission of air Rapid improvement will follow the shutting of the open pneumothorax and its conversion into a closed one and when the shock symptoms have abated more formal attempts at treatment can be carried out A lacerated wound is excised in all its layers down to the chest wall and fragments of indriven bone clothing or missile removed, but a formal thoracotomy and exploration of the pleural cavity need only be taken where there are continued signs of hæmorrhage or obvious damage to the lung

During the recent war it was found that modified expectant treat ment as described rather than extensive and early formal treatment produced more satisfactory and certainly safer results During the process of cleaning up the pleural cavity can be sucked dry of blood and the chest wall layers closed again so as to make the original opening quite airtight If any drainage of the pleural cavity is employed it must be of the water-seal closed drainage type but it is indeed wiser to avoid any form of drainage and to depend on repeated and intermittent aspirations to remove blood and fluid from the pleural cavity When the pleural cavity is aspirated penicillin (100 000 to 250 000 units) is injected at the end of each procedure Infection may supervene at a

later stage of interpleural injury and will be treated along the lines of infection of the pleural cavity i.e by aspirating early and draining only when the infection has become localised to a limited area of the pleural cavity

Hæmothorax.—Bleeding into the pleural cavity is an accompaniment of injury and presents one important feature i.e it appears to remain liquid within the pleural cavity and therefore can be aspirated with comparative ease

The reason for this liquid blood is not any peculiar failure to clot but the result of an early and rapid defibrination from the violent action and movements of the heart and lungs consequent upon the injury Any surgeon who has opened the chest in the presence of fluid will have noted the frothing appearance of blood and fluid in the bottom of the wound In other words, blood as it passes from the vessels into the pleural cavity clots, and is then rapidly defibrinated and remains liquid

The second important feature is that blood itself acts as an irritant to the pleural membrane and produces a secondary effusion This effusion has a fibrin content which in time can approximate that of the blood level and the result is that after a period of ten days or more a secondary clotting may occur This is strictly not clotting of blood but of exuded fibrin It can also occur if the liquid blood mass is secondarily infected, though in many cases the action of enzymes in the infecting agent may keep the contents liquid

The most common origins for blood in a hæmothorax are the vessels of the chest wall the intercostal and internal mammary arteries and veins Blood may also arise from lung tissue though the wound tends to close spontaneously unless the vessel torn is a large one and similarly blood may come from structures within the mediastinum including the heart though in such a case death is common The volume of blood in a hæmothorax varies from a few ounces up to as much as 4 to 5 pints before there is any necessary displacement of the mediastinum and subsequent distress The initial volume of blood is added to by the irritating serous exudate that rapidly follows and by the second or third day there is some increase of pressure within that pleural cavity The signs and symptoms of a hæmothorax are those of a pleural effusion associated with loss of blood and there is usually a small degree of fever accompanied by an increased pulse rate Shortness of breath and respiratory distress will only be noted in the case of larger effusions

Treatment—The ideal treatment is early and complete aspiration of the contained blood The risk of re-starting bleeding from chest wall vessels is remote and practically unknown after the first twelve or twenty four hours The first aspiration should be undertaken within twenty four or forty-eight hours of the injury and all the available liquid should be removed without permitting the introduction of any air The importance of avoiding air replacement is to prevent a bubble rising to the apex of the chest and allowing the lung to fall downwards. It is the apical pleural space that is most difficult to obliterate The initial aspiration which may take anything up to half an hour to perform

is followed by the introduction of penicillin into the pleural cavity and if on clinical or radiological examination there is any reaccumulation of fluid aspiration should be repeated It has the double advantage of removing the blood before there is any secondary deposit of fibrin and at the same time encouraging re-expansion of lung Even if early infection should occur aspiration is repeated and on each occasion the fluid withdrawn is examined bacteriologically until it becomes so thick that it can no longer pass through an aspirating needle

Early open drainage in such a case is a most dangerous and un desirable procedure Drainage of an infected pneumothorax can only be undertaken when the condition is completely localised

If a hæmothorax cannot be treated in the early stages the secondary fibrinous exudate will have produced a space with relatively thick walls but again aspiration should be continued as far as possible but if there is still a residual mass of secondary clot or thick wall to the pleural cavity the question of performing the operation of decortication can be considered. This is not undertaken until at least six or eight weeks after the original injury and consists in making a deliberate opening into the pleural cavity and then stripping away the whole thick lining from the chest wall and peeling it off the lung surface which can then re-expand The importance of penicillin and breathing exercises during treatment of hæmothorax cannot be overestimated If extensive decortication is required it is customary to use one or two small inter costal drainage tubes for suction on the displaced lung to encourage its re-expansion and prevent its falling away from the chest wall

Injuries to the Diaphragm

Injuries to the diaphragmatic sheet in the course of chest injuries are important on two aspects First because of a possible rupture of the diaphragm itself with subsequent herniation of abdominal contents particularly on the left side in the chest and secondarily because of the possibility of associated damage during the tearing of the diaphragm For example a bullet wound passing close to the nipple line but escaping the heart may easily puncture the fundus of the stomach and constitute a severe abdominal thoracic injury In a closed crush injury rupture of the right side of the diaphragm may be associated with injury to the liver or even kidney And it is unfortunate that a great many presumed isolated chest injuries have been treated con servatively whereas they have also involved the abdominal cavity and irrevocably injured the abdominal contents In all such suspected cases of penetrating injuries the chest and abdomen must be explored to determine the integrity of the abdominal contents and at the same time the rent in the diaphragm can be repaired by suturing with silk or thread stitches

The crush type of injury is the one most frequently associated with unexpected and late herniation and many cases of diaphragmatic hernia if their history is closely investigated give the story of some previous crush injury which had produced the necessary tear in the diaphragm though this had not been suspected at the time

Injury to the Heart

The majority of penetrating heart injuries are fatal as a result of hæmorrhage and disturbance of heart function The heart may be ruptured in the case of crush injuries particularly if it is violently compressed between the sternum and vertebral column

In penetrating injuries the pericardial sac plays an important part since if it is more or less intact the blood pouring out from the heart will collect within this sac which is not able to expand to any great extent in consequence the enclosed pericardial blood exerts pressure on the heart and impedes its action This is referred to as *cardiac tamponade.* If however the pericardium is freely torn the blood will escape into the pleural cavity and the effect will simply be that of hæmorrhage without any local added mechanical disadvantage The effect of intrapericardial pressure is to arrest the diastolic phase of the heart so that the arterial pressure falls, and in consequence the pulse rate quickens to a marked extent At the same time the failure of the heart chambers to fill will lead to a damming back of the venous side of the heart with a raising of the venous pressure The rise in venous pressure is not usually obvious in acute tamponade but becomes much more evident when the accumulation of fluid within the pericardium is slow The result of the pressure on the heart obscures the heart sounds and makes it a relatively silent organ at the same time as the pericardial sac is distended. This latter can be observed by percussion but more particularly by X ray examination when the cardiac outline instead of pulsating freely is stationary

Treatment —If the condition is promptly recognised it is possible to treat and even to save the patient's life and indeed in some countries (Southern States of U.S.A) where the use of knives and stabbing is of common occurrence surgical teams are well aware of this condition which if recognised calls for immediate exploration of the pericardium

The operation consists in exposure of the pericardium after resection of one or more costal cartilages on the left side of the sternum followed by incision of the pericardium which frees a quantity of blood under pressure If the heart wound is a small and incised one a few sutures may be sufficient to control bleeding in many cases though if the laceration is extensive it will not be possible to obtain an effective repair

If the injury is caused by a foreign body the missile may be lying against the heart walls or great vessels or may even be lying within the chambers of the heart In both positions these are of danger to the future existence of the patient and in the hands of properly experienced and trained surgeons they can be removed. In the case of foreign bodies lying against the heart or great vessels the removal is a matter of no difficulty but it requires considerable skill and experience to remove a foreign body from the actual auricular or ventricular chambers of the heart where it is usually caught up with some of the valves or chordæ tendineæ

SUPPURATIVE PLEURISY OR EMPYEMA

Infection of the pleural cavity is one of the most important conditions in the chest and before the introduction of chemotherapy the occurrence of empyema was at a high rate following pneumonic infections of the lung. The picture has however changed considerably since pulmonary infection has been more extensively controlled by penicillin and other chemotherapeutic agents.

Pleural infection occurs at all ages and is most commonly associated with lung infections. The two most commonly found organisms are pneumococci and streptococci though staphylococci *B. Friedländeri* and *B. coli* as well as other organisms are occasionally encountered.

Source of Infection.—1. **Pulmonary Conditions.**—Pneumonia particularly that caused by the pneumococcus is still a common cause of empyema and the organism reaches the cavity by direct spread from the subpleural space or by rupture of a microscopic abscess. In the days before chemotherapy pneumococcal pleural infections following lobar pneumonia arose after the crisis had occurred and were referred to as *metapneumonic* infections while streptococcal infections which occurred at the same time as the broncho-pneumonic condition in the lung was active were known as *synpneumonic*. However the whole picture of pneumonia has altered, and these terms are really no longer valid, but there are undoubtedly many lung infections which still proceed to infect the pleura though usually in a much less virulent form than in bygone days. Direct rupture of an abscess of lung or from a bronchiectatic lesion within the lung can also involve the pleura and if occurring suddenly can produce an empyema of extreme abruptness and virulence. Involvement of the visceral pleura by growth may allow organisms from the lung to be liberated in the case of carcinoma of lung.

2. **Non pulmonary Causes.**—It is doubtful if an empyema ever arises as a result of blood borne or direct infection though the infection of a pleural effusion or hæmothorax following injury is relatively frequent. A lymphatic spread of infection from below the diaphragm may occur in the course of a subphrenic abscess or amœbic abscess of the liver and also take place in the course of œsophageal carcinoma.

Pathology.—Two stages of pleural infection are to be recognised and these should be kept clearly in mind in view of the difference of treatment though one stage merges gradually into the other. As soon as an infection occurs the pleura reacts by pouring out a clear serous exudate containing a certain amount of fibrin. Bacteria will be recognised in this fluid which after two or three days will become turbid in character and show the appearance of thin pus. At this stage the whole pleural sac is potentially involved and the term *diffuse suppurative pleurisy* should be used for this aspect of the infection. In the course of a few more days the turbid fluid becomes thicker as cellular elements predominate within the fluid and pure pus is then recognised. Fibrin is being secreted and a certain amount of fibrinous flakes or deposit appears within the pleural cavity. Organisms are freely present and culture of the pus will show their character but if chemotherapy has been employed

it is quite common to find the shadowy dead outlines of bacteria and to obtain a sterile culture The fibrin tends to become deposited on the visceral and parietal pleura and the thickening of this latter coat can be recognised by the aspirating needle when it is inserted into the chest. At the end of a week or ten days the pus becomes so thick that it does not readily pass through a small-sized aspirating needle which may easily become blocked by flakes of fibrin At this stage the pleural infection is starting to become well shut off so that a *localised pleural abscess* is formed this is what should truly be called an empyema If not cured at this stage the walls will progressively thicken from the deposition of layers of fibrin and the enclosed pus will become dense and even inspissated.

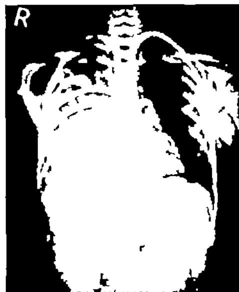


FIG. 230
An acute empyema on the right side before drainage.

Later organisation of the fibrin into fibrous tissue will prevent the lung from re-expanding and will contract the chest wall giving rise to loss of movement and even to deformity

Pneumococcal infections tend to produce masses of fibrin at a relatively early stage whereas streptococcal infections tend to maintain thin pus for a longer period and to localise more slowly

Signs and Symptoms —The persistence of fever or toxæmia after a pneumonic condition has appeared to settle is always suggestive of the possibility of pleural infection Irritation of the pleura may produce severe pleural pain and signs of dullness at the base with loss of breath sounds are common. It should be recalled however that in children it is extremely difficult on clinical examination to detect the presence of an empyema since the breath sounds are frequently not diminished, and are only converted into those of bronchial character When the effusion attains a certain size there may be actual displacement of the mediastinum but where possible radiological examination should be made in the early stages and the uniform basal opacity lying principally in the axilla will have been observed (Fig 230) Constitutional signs of retained toxic products are present if the condition has not been controlled by chemotherapy or other treatment and a leucocytosis can also be anticipated if chemotherapy has not been used Once a suspicion of empyema has been raised the only real conclusive proof is the aspiration of pus, and this *diagnostic aspiration* is a procedure that has to be undertaken early and with the utmost caution early to provide prompt diagnosis cautiously so that the needle does not puncture infected lung and release organisms into a pleura that might not have been infected. As a rule the

first aspiration is only undertaken when the condition has passed from the diffuse suppurative phase into that of a localised abscess and here the thickened pleura can easily be felt on the passage of the needle

Treatment —Treatment is divided into two aspects the treatment of the acute diffuse stage and the treatment of localised pleural abscess. In both cases it will aim at two effects —

1 The removal of toxic products
2 The obliteration of the infected pleural space and the full re expansion of lung It should be stressed that aspiration is a form of drainage which is intermittent and imperfect but has in this instance the supreme advantage of preventing the admission of air and being a much more simple procedure than any surgical drainage operation

SUPPURATIVE PLEURISY —Treatment commences with diagnostic aspiration which as has been said, reveals the type and the quality of the pleural fluid Bacteriological examination would determine the character of the infecting agent and also its response to chemotherapeutic drugs If the pus is thin or only slightly turbid then aspiration must be repeated. The first formal aspiration must be complete and no air must be admitted through the needles A well fitting syringe a two-way tap and an appropriate supply of needles are necessary The skin is anæsthetised with dilute procaine solution and the proposed track also infiltrated down to pleura The needle with syringe is then inserted and the thickness of the pleura can probably be detected by experienced hands. The pleural fluid is then aspirated completely even though the procedure may take twenty minutes to half an hour and when all possible fluid has been removed penicillin (250 0000 to 500 000 units) is injected Aspiration is repeated again as often as the fluid or pus re-collects, or until it is no longer possible to withdraw the pus through the needle Wider needles may be used, but sooner or later they will become blocked by fragments of fibrin and loose tissue lying within the fluid, and at this stage if the pus is thick the condition will be approximately that of a localised abscess and aspiration will be no longer of full value

LOCALISED PLEURAL ABSCESS —When true localisation has occurred, as is shown by the thickness of the pus the presence of fibrin and thickening pleural walls, the question of formal surgical opening of the space can be considered.

If the fluid is infected it is important to provide *adequate drainage* and this can be achieved only by resecting 2 to 3 in of rib evacuating the contents of the empyema and inserting a wide-bore drainage tube Should drainage have been performed too early *i.e* before the localisation is complete then the drainage must be attached to a closed water-sealed system though this has the disadvantage of immobilising the patient to some extent (Fig 231) If previous bacteriological examinations have shown that the contents of the pleura are sterile a slightly more difficult problem arises It is unsafe to leave a persistent pleural cavity even though sterile The space must be obliterated and this can be achieved either by opening the empyema and evacuating the contents

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and then proceeding still more energetically with breathing exercises or in selected cases by excising the whole empyema cavity This *pleurectomy* which is an elaboration of the decortication operation, requires a thoracotomy incision over the empyema and after the parietal layer has been separated the dissection is carried round the margins of the sac and on to the lung where the visceral thickened pleura is peeled off the lung surface Suction drainage is used after the opera tion to encourage the expansion and breathing exercises are energetically pursued. This form of operation is not usually undertaken till two to three months have elapsed since the start of treatment and when the cavity shows no sign of diminishing on account of the extreme thickness of its walls

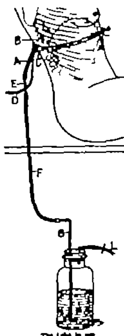


FIG 231

Tudor Edwards water seal drainage

A, the main drainage tube; B, its internal flange; C, its external flange; D, lateral catheter for irrigation; E, F and G, glass and rubber connections to bottle maintained at negative pressure via tube L.

Drainage and Tube Control.—Certain element ary principles must be remembered in the drainage of any empyema, and though these are quite simple they are frequently overlooked. The drainage tube must be placed at the most dependent part of the cavity and the tube draining the contents must be of adequate size or bore and not too narrow Moreover the drainage must be maintained until there is complete obliteration of the pleural cavity itself The site chosen for operation can be deter mined either by the aspirating needle or by injecting a few cubic centimetres of radio-opaque oil into the empyema cavity and then taking a lateral and anteroposterior radiograph The operation is performed under local anaesthesia preferably with the patient in a sitting position since this avoids any danger of spill of pus into a bronchial fistula leading into the lung A short length of rib is carefully resected and the thickened pleura over the cavity is excised and the contents are carefully and fully removed. Inspection of the interior of the cavity is also desirable and this can be effected with a small malleable lamp and when the surgeon is satisfied that there are no undrained pockets a wide-bore tube is inserted so that the interior end does not press on lung tissue or on the far side of the empyema cavity The tube is then fixed securely in position by a safety pin held to the skin by two narrow strips of adhesive plaster and after the first two or three days the amount of drainage from the space should be practically minimal There should, however be no question of the removing or altering of the position of the tube even though the discharge has stopped until a complete visualisation of the interior of the cavity has been obtained This can be effected by the use of pleurograms which are radiographs taken in two planes after filling of the space with radio-opaque oil and by following these principles the healing of the cavity can be observed Tube control is

of the utmost importance and the most simple error therein is too frequent changing of the tube for cleaning purposes There is no reason why a tube should not be kept in place for several weeks so long as it remains comfortable from the patient s point of view and is still maintaining adequate drainage

Cavity Healing—As the lung starts to re-expand the shape and size of the cavity alters and a comparatively oval-shaped cavity may perhaps become one in which bottle-necks or even odd pockets tend to become shut off by the expansion of the lung at the base In such cases the pleurograms will demonstrate the presence of an approaching or threatening bottle-necked track and then the tube will have to be lengthened through the neck so that it lies within the bulb that requires effective drainage Then again further pleurograms will demonstrate the healing of the bulb after which the tube can be withdrawn at regular intervals again after a check on each occasion until the empyema is completely healed If the pictures show any outlying pockets that have been missed these may require separate drainage

Breathing Exercises.—During the whole process of treatment the most active and hopeful measure that can be used is breathing exercises. These are of a vigorous inspiratory character aiming at developing re-expansion of the lung that has been collapsed or compressed by the empyema and these have to be controlled by the patient who concentrates his efforts on the area of the chest wall over the lesion These exercises in addition to general postural treatment to prevent any deformity must be persisted with several times each day ten minutes during each hour is not too much They are not exercises only to be performed in the presence of a physiotherapist they are to be carried out energetically by the patient every waking hour and to be carried on with increasing intensity until full function of the lung has been regained There are many minor points in the treatment of empyema which are important but the fundamentals are the maintenance of the tube its correct position in relation to the interior of the cavity and fixed firmly against the patient s chest wall so that it is comfortable and not causing pain with a covering of a light non-restricting corset dressing and effective breathing exercises

Complications—During the course of any diffuse suppurative pleurisy certain complications may arise Some of these are of a toxic nature and include pericarditis and rarely peritonitis, and the definite risk of meningitis or cerebral abscess The other complications are mechanical in character and include rupture of the abscess contents into a bronchus producing a broncho-pleural fistula rupture through the external wall into the subcutaneous tissues producing empyema necessitatis in which a fluctuating swelling presents over the chest wall sometimes at a considerable distance from the actual empyema itself After drainage has been established there are possible complications in the shape of hæmorrhage which may result from pressure of the tube against lung or from actual ulceration of the track through the chest wall when an intercostal vessel may be involved Pain and neuritis may also occur as a result of pressure on an intercostal nerve and can be treated by injection with procaine or alcohol

At one time irrigation of the pleural cavity was popular but there are certain dangers in this procedure if a bronchial pleural fistula has not rigidly been excluded since the irrigating fluid can easily flood the lungs and might even drown the patient Antibiotics and antiseptics can be used to improve the bacteriological flora of the empyema cavity which is inevitably contaminated from without as drainage persists in fact there is a considerable advantage in closed aspiration methods so long as the need for obliteration of the cavity is not lost sight of.

CHRONIC EMYPEMA

Chronic empyoma is usually the result of inadequate or imperfect treatment of the acute phase of pleural infection but it can also be due to some underlying and unrecognised lung disease such as tuberculosis, actinomycosis or carcinoma It can be classified under several headings —

1 Chronic undrained empyema
2 A chronic empyoma with an external sinus
3 A chronic empyema cavity with a bronchopleural fistula

A chronic undrained empyema is by no means rare Gross thickening of the pleura more marked on the parietal side than on the visceral, with the barrier of fibrous tissue prevents to some extent the absorption of toxins The symptoms vary considerably but in general the patient feels ill or at best off-colour with a low-grade temperature and usually a chronic cough discomfort in the chest and loss of appetite In many cases signs of chronic toxaemia such as loss of weight and sweating and clubbing of the fingers, are frequent In most patients there is some retraction of the chest wall and this may be severe in young patients and associated with scoliosis and other thoracic deformities. It may be that a long interval even that of years has elapsed between the acute stage and recognition of this chronic pleural pocket which can only finally be determined after radiological and clinical examination of the site involved followed by use of the aspirating needle

The chronic empyema with an external sinus is usually the result of maltreatment of the acute stage Drainage has been performed, but tube management has been imperfect so that a small discharging sinus follows inadequate for proper evacuation of the empyema cavity contents The commonest cause used to be daily changing of the tube for sterilisation purposes succeeded by the failure to return the tube to its original position In consequence a smaller tube was used and this process by repetition resulted finally in a pin point sinus. The amount of discharge from such a cavity varies If drained at the most dependent position there will not be a large amount of pus but if the drainage opening is too high there will be a continual spill-over from the pocket below the opening The external sinus may sometimes close and then reopen if there is any recrudescence of infection Occasionally the persistence of such a chronic empyema is due to the retention of a foreign body and drainage tube swabs and pieces of necrotic bone have on occasion been responsible This type of empyema is investigated

simply by injection of radio-opaque oil so that the internal dimensions can be studied (Fig 23*) This is then followed by making a further opening for drainage usually along the position of the residual sinus a pleural biopsy can also be made and a wide-bore drainage tube inserted.

Chronic Empyema with Bronchial Fistula.—Sometimes an empyema cavity may discharge itself without external drainage by rupturing into a bronchus and being coughed up Rarely healing may result by this method but more commonly there is persistent cough associated with a variable amount of purulent sputum as the contents of the empyema are discharged into the bronchus across the lung As a result bronchiectasis and secondary lung changes are common and the condition is easily confused with long-standing bronchiectasis or lung abscess The necessity of draining such a collection to save the lung from further damage is obvious

Investigation and Treatment — The first essential is a proper investigation of the chronic empyema to obtain some idea of its situation and size Radiography will help and give some broad idea of the position and this may even be simplified by the visualisation of the fluid level In a closed case the aspirating needle will pass through a very thickened wall and thick or even inspissated material will be obtained through the needle The bacteriology can then be determined, and at the same time radio-opaque oil can be injected into the cavity and further radiographs taken for localisation of the most dependent point The next step is to obtain adequate drainage which is done by a formal rib resection operation with inspection of the interior of the contents and with routine biopsy of the full thickness of the parietal pleural wall Efficient drainage is then maintained and it will be found that where no underlying cause is responsible steady and progressive healing of the cavity will follow so long as intensive breathing exercises are used. It may take weeks or months for a chronic cavity to close but as long as there is some improvement with ordinary drainage physiotherapy can be persisted with and will ultimately produce complete healing in the large majority of patients. If for any domestic or economic reasons there are some difficulties with tube control or dressing i.e a poor patient living at a long distance from a hospital it is possible that a U-shaped skin flap can be devised at the time of the rib resection and this flap then be turned into the wound so that an epithelialised track through the chest



FIG. 232

The X ray appearance of a chronic empyema with external sinus after injection with Lipiodol.

wall is obtained. This will afford adequate drainage without requiring a tube

Should drainage methods fail there are two forms of treatment that can be adopted. One is to mobilise the pleura or the chest wall over the empyema surface and allow the parietal layers to fall in on to the lung. The other is to remove the thick pleural layers off the lung and to allow the previously compressed lung to re-expand. This requires a free exposure of the empyema and the success of this "decortication" depends on the presence of a plane of cleavage between lung and pleura. The elaboration of decortication into a formal excision of the whole empyema cavity has proved successful. The pleuro plastic operations on the chest wall which have had the names of Estlander, Schede and other surgeons attached to them have largely fallen into disrepute and rightly so since their performance admits a definite loss of lung function and some inevitable deformity. The aim should always be to re-expand lung where possible and in the decortication or pleurectomy type of operation removal of the visceral layer from off the lung and the parietal layer from the inside of the chest-wall allows for freer movement and possible re-expansion of the lung with obliteration of the space.

Chronic empyema is a grave and crippling condition the cure of which will inevitably take a period of months and which should be largely reduced by proper attention to the acute stages of the disease. A surprising degree of carelessness and inattention to first principles has been responsible for many of the chronic empyemata that come within the purlieus of the thoracic surgeon.

PULMONARY SUPPURATION

Under the heading of pulmonary suppuration are a number of important conditions which may be related or co-existent. These include suppurative pneumonitis, lung abscess, gangrene of lung and bronchiectasis, and all are characterised by toxæmia and cough with purulent sputum.

Suppurative Pneumonitis

This term can be used to cover a severe infection of lung or pneumonitis in which persistent suppuration occurs in the lung parenchyma. Fever and toxæmia are always present and may be severe, also cough which produces a quantity of pus varying from an ounce or so up to a pint in twenty four hours. The condition is not a clear-cut clinical entity though one variety referred to as "spreading suppurative pneumonitis" extends through the whole of one lung with formation of abscesses and some spontaneous resolution.

The condition if treated energetically with penicillin (2 000 000 units per diem) improves though it leaves bronchiectatic and fibrotic areas which may require later excision.

Lung Abscess

A localised suppurative lesion in the lung which liquifies in the centre with a surrounding zone of inflammation (pneumonitis) and fibrosis, is

referred to as a pulmonary abscess There are several recognised forms of this condition but only one which is popularly accepted as a true lung abscess

Varieties.—1 **Obstructive.**—This is the most common form and results from obstruction of a segmental or sublobar bronchus by infected material Atelectasis follows and the severity of the infection produces a necrotic centre in a zone of pneumonitis Persistence of the suppuration with obstruction of the draining bronchus leads to rapid distension of the spherical abscess

The infected material is often derived from the teeth and gums tonsils and nasal sinuses and may follow the inhalation of any vomitus or infected mucus during or after operation Foreign bodies can also be responsible metal toys and food particles particularly meat bone or pea-nuts grass or vegetable seeds are well recognised examples.

2 **Pneumonic.**—Considering the frequency of pulmonary infection the rarity of a clinically recognisable lung abscess is surprising Strictly a tuberculous cavity might be included in this category but the term "abscess" is confined to more acute conditions Multiple small abscesses may develop in pneumococcal and streptococcal pneumonia, but a large single abscess is uncommon.

Staphylococcal pneumonia can beget enormous distension abscesses which resemble cysts and which in children may be associated with tension pneumothorax In spite of a turbulent course these cases resolve satisfactorily Infection of lung with *B Friedländeri* may be associated with abscess formation and in this type the pneumonic element dominates the abscess in contradistinction to the obstructive form where the break-down is more important

3 **Embolic.**—In septicæmia blood borne foci of infection may be deposited in the lungs Multiple abscess formation occurs and these abscesses distend with alarming rapidity Subphrenic infections subacute infective endocarditis and osteomyelitis are examples of the source of infection and some examples of staphylococcal abscess and actinomycosis are included under this heading The course of multiple embolic abscess is progressive and in many cases fatal from the sepsis in other parts of the body as well as the lungs Chemotherapy affords the only hope of cure in severe cases

Infection of a lung infarct producing an abscess is a rare occurrence

4 **Carcinoma of Lung**.—Two forms of abscess are encountered in pulmonary carcinoma The first occurs from central breaking down of the growth as the result of degeneration and the walls of the cavity are irregular and uneven in thickness This contrasts with other forms of abscess in which the cavity is central and the walls are uniform The second form is an obstructive abscess occurring distal to the growth which has traversed and almost completely obstructed the bronchus Pent up infected secretions convert this area of potential collapse into an abscess

5 **Infected Cysts.**—A pulmonary or a hydatid cyst gives rise to a condition indistinguishable from an abscess when infection has reached the cavity from a bronchus

6 **Direct Spread.**—Subphrenic or perinephric abscess and amœbic abscess of liver rupturing through the diaphragm into the lower lobe and œsophageal ulceration and growths are examples of infection which may produce an abscess in the lung The pus is usually coughed up after rupture into a bronchus.

7 **Injuries.**—Penetrating wounds may carry infection into the lung but abscess formation is rare unless foreign matter (piece of clothing bullet shell fragment) is retained in the lung tissue The development of this abscess may not take place round the foreign body for some years after the original injury

Pathology—The acute necrosis that precedes the actual abscess formation leads to destruction of tissue with the production of a slough which lies in the abscess cavity The walls of the abscess consist of compressed and consolidated lung tissue and the lining shows all the characters of a pyogenic membrane The draining bronchus is œdematous and obstructed precluding the evacuation of the contents and the degree of obstruction determines the fate of the abscess. If the contents can drain away resolution is possible but the usual course of events is that the abscess distends progressively over a period of weeks until removal of the bronchial block by ulceration into a bronchus allows the abscess contents to drain

Retention of secretions and persistence of infection account for the toxæmia and fœtor that are the principal feature of the condition. Anaerobic organisms and sloughing tissue are responsible for the foul smell The bacteriological picture is confused and pure cultures of a specific organism are only found in the case of staphylococcal and *B Friedlanders* infection

The situation of an obstructive abscess is important and nearly every example is confined to the posterior segment of the upper lobe or to the apex of the lower lobe The presence of an abscess in any other region should be regarded as being possibly due to some other pathological factor *e g* a growth The abscess as it distends lies close to the pleural surface and produces adhesions so that if properly localised there are only 1 or 2 mm of lung tissue between the pleura and the lung cavity (Fig 233)

Course—Associated with every abscess are pneumonitis in the surrounding walls and pleural adhesions Bronchiectasis is a regular development which complicates the late picture An acute abscess may be coughed up during the first two or three weeks and rapid healing follows. This is common in children but in adults a chronic abscess is more usual In this event the signs and symptoms persist with varying severity until the abscess ruptures into a bronchus and is coughed up. The walls become fibrous and rigid but if the contents are drained the compressed lung re-expands and obliterates the space Normal healing by fibrosis usually follows but epithelialisation is possible in chronic cases and in this event a ring like radiological shadow persists, representing a thin walled cavity which may become reinfected at a later date

Signs and Symptoms—The onset is characterised by a sudden illness often associated with a rigor and high fever and the signs of

pulmonary inflammation On occasions there is a definite history of an inhaled foreign body or of an operation but in recent years possibly connected with the advent of chemotherapy a proportion of abscesses have a mild and insidious onset Cough accompanied by sputum which rapidly becomes offensive is an early and only too easily recognised feature The sputum is purulent yellow or black in colour and may be blood-stained The quantity varies sometimes being minimal although the fœtor persists but attaining a volume of several ounces, even a pint if there is free drainage from the abscess The signs are equivocal and practically never those of a pulmonary cavity Dullness,



FIG. 233

A, anteroposterior view B, lateral view of left lung abscess. Note the fluid level, especially in B.

diminished breath sounds and some râles are the most common findings, and localised tenderness over the abscess can be determined

Clubbing of the fingers and toes may develop rapidly and with the generalised toxæmia anæmia is severe

Radiological Examination—In the early stages a pulmonary abscess appears as a rounded or triangular shadow in the translucent lung field. This shadow is situated with its base towards the periphery of the lung and there are two especial sites in which a lung abscess is commonly found These are in the posterior segment of the upper lobe and at the apex and posterior part of the lower lobe Both these areas are hidden by the shadow of the scapula and their detection is therefore a little more difficult As soon as there is any rupture of the abscess the fluid level becomes apparent with a small clear zone of air above the more solid fluid in the rounded abscess itself A certain degree of less well-defined shadowing lies in the periphery of this rounded area and represents the pneumonitis and fibrosis associated with the condition

It is essential in all cases to have lateral radiographs as well as the ordinary anteroposterior forms for it is only really in the lateral positions that the true localisation of the abscess can be obtained

Investigation —After the radiological examination a careful attempt to study the bacteriology should be carried out but even though a large rounded shadow appears any attempt to aspirate the pus from within the lung is absolutely contraindicated. Should an aspirating needle pass through a non adherent pleural layer the production of a total and very virulent form of empyema is most probable

Treatment —**General Condition.**—Particular attention must be paid to the general condition in view of the severity of the toxæmia The associated anæmia must also be combated either by drugs or by transfusions of blood

Postural Drainage.—If an abscess has ruptured into a bronchus drainage can be encouraged by placing the patient in such a position that the draining bronchus is dependent In the majority of abscesses this is achieved by placing the patient on the face with the head slightly downwards and the affected side a little higher than normal In this way the base of the abscess at the posterior part of the upper lobe or at the apex of the lower lobe will be uppermost and drainage though not necessarily fully adequate will be encouraged.

Drugs.—Many drugs have been used in the treatment of lung abscess some of them being to relieve symptoms including such agents as creosote others aiming at altering the bacterial flora and of these arsenical preparations in former years held a place. More recently however the introduction of antibiotics has altered the picture considerably and modern treatment of lung abscess is largely dependent on their use Penicillin is the most important but it should be realised that it will not be effective in ordinary routine small doses and must be used in massive and prolonged doses to obtain a beneficial result The standard now used is 2 000,000 units per day for a period of four to six weeks

If an organism sensitive to streptomycin is found this drug 1 gm. per day can be used Adequate chemotherapy has so altered the treatment that lung abscess can now be regarded as a medical rather than surgical condition The effect of penicillin is to reduce the inflammatory changes round the abscess and thus to relieve the swelling in the bronchi and so encourage drainage and at the same time the contents appear to be liquefied and evacuated through the draining bronchus or bronchi. Radiologically the surrounding pneumonitic changes tend to disappear and the actual abscess itself may become progressively smaller though it is not uncommon to find that a thin ring-shaped outline is left at the end of treatment This represents a thin walled and possibly epithelialised cavity which gives rise to no symptoms unless a recurrence of infection follows. Such a chronic and apparently healed abscess is admittedly a mild and potential source of danger and if there is any recurrence of infection further treatment in the form of resection may be required

Bronchoscopy —Bronchoscopy is a useful measure not so much in treatment as to ensure that there is no obvious obstruction to the draining bronchi which may persist with the inflammatory changes Bronchoscopy can confirm the presence of a foreign body or the existence of a growth

Surgical Measures.—Formerly collapse therapy in the form of artificial pneumothorax phrenic evulsion and even thoracoplasty were regarded as

possible measures for treating a lung abscess by compression and attempted obliteration. These are methods fraught with considerable dangers and have no real place at the present time

Drainage of lung abscess (pneumonotomy) was the standard treatment for a chronic lung abscess which had shown no attempt at resolution after several weeks expectant treatment Drainage was carried out directly over the abscess where not more than 2 or 3 mm of lung would have been traversed and this could be accomplished in one stage if the pleural layers were firmly adherent If however and this was often the case the pleural layers were only held together by thin or filmy adhesions the operation was performed in two stages The first involved a resection of a length of rib packing the space with a swab soaked in iodine to promote firm adhesions and subsequent closure of wound After an interval of two weeks this wound was reopened and the surface of the lung cut into with diathermy until the cavity was freely laid open The complications of pneumonotomy were formidable hæmorrhage from lung and cerebral abscess being among the most common.

Excision.—Excision of a segment or lobe containing a lung abscess in the acute stages is contraindicated, but a localised excision of the residual or virtually healed abscess and associated bronchiectatic areas is frequently carried out if there has been any recurrence of the infection in the same area or site These procedures consist in sharp febrile attacks accompanied with a cough and purulent, probably offensive sputum. There is some radiological increase of shadowing in that area and once the condition has subsided under penicillin therapy the question of a segmental or lobe excision may have to be reviewed

The whole treatment of lung abscess, and indeed of lung suppuration has altered considerably during the past two or three years and what was an alarming and difficult problem has now become simplified, though there are still many anxious moments in the acute stage and complications are not completely avoided The use of blood transfusions of aerosol penicillin inhalation and other ancillary aids should not be overlooked if circumstances demand.

BRONCHIECTASIS

By definition bronchiectasis denotes dilatation of the bronchial tubes with or without superadded infection Radiologically if a bronchus is dilated it is entitled to be referred to as bronchiectatic but formerly clinical bronchiectasis admitted the addition of infection so that cough and purulent sputum were constant features of the condition

The present conception of bronchiectasis is largely based on the existence or presence of atelectasis as a preceding agent If atelectasis occurs and persists the previously ventilated zone of lung is converted into an airless mass of small elastic fibres and almost complete absence of alveoli or aerating tissue This elastic mass exerts traction on all surrounding structures pulling the mediastinum towards itself elevating the diaphragm, contracting the chest wall downwards and producing compensatory emphysema of the adjacent lung Within this contracted mass the bronchi are shortened and as a result become more stumpy but this is not necessarily to be confused with bronchiectasis itself In this stagnant or atelectatic area infection is not likely to be eradicated readily and if persistent infection occurs there is probably some weakening of the peribronchial structures which when submitted to continuous

elastic traction tend to enlarge and dilate Now the amount of dilatation that is possible will depend upon the structure and resistance of the actual bronchus wall In the case of large bronchi in which the firm elastic and cartilaginous structure makes them rigid tubes, the dilatation will be minimal and of a uniform character producing so-called cylindrical bronchiectasis In smaller sized air tubes the dilatation will be more marked and a sacular or glove finger like enlargement is found In a terminal bronchus where the tube is only thinly protected, considerable enlargement or even diverticular like formation is possible thereby producing a cystic or grape-like appearance

The clinical picture of the bronchiectasis will then be determined by the amount of infection that occurs in the distended and possibly stagnant air tubes Many cases of apparently advanced bronchiectasis are known to be comparatively dry but in others a persistent and prolonged infection produces inordinate quantities of purulent sputum each day

The agent or object causing bronchial obstruction may be obvious, as in the case of a foreign body but more usually glandular pressure is applied to the hilar region If then there is added some intercurrent infection or bronchitis leading to mucous secretion an obstructing plug is formed. If this plug completely occludes a lobar bronchus the rapid absorption of air will drag the mucus downwards into the finer air tubes, rather like a horse s tail where the obstruction will again be confirmed. This explains why even though a sudden atelectasis or massive collapse occurs there is often no visible obstruction at the actual opening of the lobar bronchus. Glandular enlargement in children is common as a result of whooping-cough or some other exanthemata. In the case of whooping-cough the persistent violence of the cough may add some mechanical effect to dilate already pathological air tubes, but the original conception of pleural drag and raised intrabronchial pressure are not commonly thought to have much cause or effect in the production of bronchiectasis.

Histologically the most remarkable feature of bronchiectasis is the integrity of the bronchial epithelium This is of a high columnar and ciliated form and though there is desquamation active ulceration is only seen in occasional areas. The peribronchial tissues are heavily infiltrated by inflammatory cells but even here their elastic and muscular elements are not grossly destroyed The space formerly occupied by alveoli and aerated tissue is represented by small elastic fibres with secondary fibrosis and marked inflammatory changes and sclerosis is noted in the blood vessels. Pleural adhesions may be present over bronchiectatic areas particularly where there have been repeated and recurrent inflammatory changes, but in some instances their complete absence is somewhat surprising

In addition to the possibility of obstruction of a bronchus by glandular pressure and by over-sticky or viscid mucus the question of infected particles inhaled from the upper air passages particularly the nasal sinuses has to be borne in mind It is felt that in many cases of diffuse and patchy bronchiectasis infection from these nasal sinuses is a potent source both of obstructing material and of later infection

The disease is most commonly found in the lower lobes and is frequently unilateral suggesting that a glandular obstruction may have been the predisposing cause The condition can occur in very early life but surgical interest is centred on the disease when it appears in children and in young adults Its occurrence in more elderly patients can also be noted and many cases of alleged chronic bronchitis are on closer investigation found to be due to bronchiectatic changes in the lung Similarly in tuberculosis or any other pulmonary disease a certain amount of secondary bronchiectasis is almost always found but it is not with these forms that we are principally concerned.

Signs and Symptoms—Cough and the production of mucopurulent sputum are the most characteristic features of the disease and the sputum varies from a trace up to some ounces In the classic advanced description it will separate out into three layers an upper frothy layer a clear intervening layer and a thick sediment or deposit at the bottom In such cases if the sputum is in any quantity the condition is almost certainly advanced and there will be marked foetor The volume of sputum that is coughed out each day should be carefully measured Even so this cannot be regarded as an index of the total amount of pus secreted by the bronchiectatic areas each day since a large amount is invariably swallowed. This particularly applies to children who do not ordinarily expectorate until they have reached the age of 6 or 7 years. In these children the cough is characterised by a wet or bubbly sound and if the character and volume of sputum is required a gastric lavage should be performed first thing in the morning

The majority of sufferers from clinical bronchiectasis are very liable to coughs and colds and may be described as distinctly catarrhal—snuffly in the nose with a continual laryngeal in addition to the more marked chest type of cough Catarrhal children with wet noses and wet coughs have also uneasy and unsteady bowels catarrhal indeed from nose to anus Any cold caught by one of these patients invariably descends to the chest giving rise to increased cough and expectoration Pneumonic attacks are also common and in many cases the history is characterised by the occurrence of several onslaughts of pneumonia always in the same area These represent retentions of secretions with some surrounding and additional pneumonitis rather than a true or classical lobar pneumonia Hæmoptysis is common and occurs in a large proportion of cases. It is particularly likely to ensue in the so-called dry hæmorrhagic bronchiectasis in which sputum is not a dominant feature Clubbing of the fingers does occur but is not specially prevalent in early cases The clinical signs are variable usually some dullness over the affected base with loss of air entry and diminished air sounds. The characteristic feature is the persistence of leathery loud râles which alter on coughing but rarely disappear Above all in children toxæmia and disability cannot be lost sight of Such children with frequent colds and coughs are impeded in their ordinary schooling little better indeed than chronic invalids. In advanced cases with much involvement of the bronchial tree the secondary changes and fibrosis interfere with respiratory function and chronic disability with shortness of breath and cyanosis is noticeable

Investigation.—Investigation of a suspected case of bronchiectasis is almost entirely dependent upon *bronchography* in which a radio-opaque oil is introduced into the bronchial tree so that a complete outline or pattern of the suspected areas is formed The anteroposterior and, in particular the lateral radiographs allow for an accurate determination of the air tubes involved and the general extent of the disease This is essential before any surgery is contemplated.

Bronchography—*Before bronchography is undertaken there should be* an attempt to empty all pus and purulent material from the air tubes by postural drainage This involves placing the patient in a position in which dependent drainage is most possible and when the bases of the lungs are

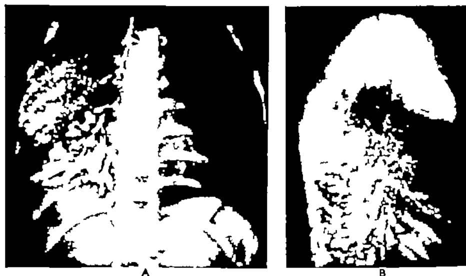


FIG 234

Bronchogram of moderate degree of bronchiectasis.
A, anteroposterior, and B, lateral views.

affected this implies a head-down position Once the bronchi are as clear as possible the opaque oil (lipiodol, neohydriol) is introduced very slowly through a short stout needle through the cricothyroid membrane or upper rings of the trachea or through a catheter introduced between the cords. Then by posturing the patient the oil is allowed to trickle slowly down in order to map out the interior of the air tubes (Fig 234) With the patient in a sitting posture the lower lobes are easily filled, but when the middle lobe has to be outlined the patient must be inclined well forward and in the case of the upper lobe so placed that the head is slightly downwards, the oil flowing upwards. It is customary to do one side at a time for if both sides are filled at the same sitting confusion in the lateral radiographs is inevitable since both sides will be overlapping When every lobe of the lung has been outlined it is possible to determine the exact location and nature of the bronchiectatic changes At the completion of the bronchogram it is important by suitable changes of posture to make the patient cough so that all available oil is expelled from the lungs. If it remains it leaves persistent radiological shadows for a period of months and even years, and round *the residual oil there is evidence* that some foreign body reaction occurs. The operation is always performed under local anaesthesia except in the case of babies or young children

who are not co-operative and in whom a general anæsthetic will be required. Considerable skill is required to obtain good pictures

Bronchoscopy—Bronchoscopy is a valuable method of investigation to be carried on in most cases, because unexpected foreign bodies may be detected and growths, ulceration or other degree of inflammation visualised and the extent of damage determined.

Complications—**Empyema.**—This is a common complication of bronchiectasis due to rupture of a bronchiectatic abscess or of transgression of the infection across the pleural cavity The empyema is often localised and may be fœtid After correct drainage the symptoms of the bronchiectasis frequently subside and in some cases it is difficult to determine if an empyema has been the primary cause of the bronchiectasis as a result of a bronchopleural fistula or whether the empyema is secondary to a pre existing bronchiectasis.

Cerebral.—A brain abscess or meningitis may occur at any time in a bronchiectatic subject This infection, which reaches the brain by direct embolism through the systemic circulation from the lungs produces a lesion which until recently was found to be fatal. Modern improvements in technique involving the use of chemotherapy and cerebral surgery have been able to save a number of the patients so affected. When the cerebral state has been cured the bronchiectatic lesion must be eradicated if possible to prevent a recurrence

Treatment—Treatment can be divided into *general* and *local*

Under the heading of General Treatment are the usual measures for the elimination of toxæmia—good diet and good economic conditions and above all the exclusion of septic foci where possible The most important of these are the nasopharyngeal sinuses and tonsils, and here radical elimination of all sepsis is difficult so long as the patient is coughing up infective material from the lungs. In other words it is a vicious circle the sepsis in the nose and throat may be inhaled into the lung and maintain infection the sepsis from the lung particularly if postural drainage is used will maintain the trouble in the sinuses. It is customary to try and remove the worst aspects of the sinus infection before considering any other treatment Climate may also play some part in the general health and it is noticeable that relatively dry and warm climates will favour the catarrhal type of subject though where the bronchiectasis has been probably due primarily to gland obstruction little benefit will be noticed. The use of such drugs as creosote has a temporary beneficial effect but expectorants as a whole are rarely needed since the cough is easily productive Inhalation therapy particularly with penicillin in aerosol form certainly has a helpful action in removing some of the bacteria from the pus but this is not a form of treatment that can be persisted in indefinitely since if all the sensitive organisms are removed from the pus it may be found that coliform and other insensitive organisms are left behind.

Local Conservative Treatment.—Apart from the general measures local treatment of the lesion after it has been accurately localised is *postural drainage* to enable the pus to follow the action of gravity rather than have to be coughed out of the lung

Since bronchiectasis usually affects the bases of the lung the correct postural position for drainage is with the patient head and face downwards so that the base of the lungs is uppermost. This can be achieved by inverting the body over a wedge whose centre should be at least 18 or 20 in. high The body and head lying down one side of the incline the thighs and legs the other If this form of treatment is carried out conscientiously for two to three hours a day even the most severe cases may gain considerable relief It acts as a

continuous drainage even though on occasions there may be much less cough than formerly With intelligent patients it is sometimes possible to encourage them to sleep in this position and thus have six to eight hours of postural drainage without interference of their daily activities. If the bronchiectasis is situated towards the apex the erect posture is suitable and if it involves the middle lobes or lingula process of left lung then the patient lying flat on the back would be the correct drainage position but these factors must be carefully studied after the bronchograms have been performed

A serious disadvantage of postural drainage is the fact that the pus by gravitating up the air passages will collect or pool in the nasopharynx and almost certainly will infect the sinuses If any patient with bronchiectasis catches a cold it is wise to have them in bed or certainly confined to the house for two or three days since these infections invariably make the cough much worse and may retard progress for some time

Operative Treatment.—The use of bronchoscopy in bronchiectasis is to remove some of the secretions that the patient may not have been able to cough up or has been too lazy to remove completely But as a therapeutic measure bronchoscopy cannot be regarded as very effective The next mode of attempted treatment at one time practised was some degree of collapse therapy But it can safely be affirmed that all collapse measures should be abandoned in the treatment of bronchiectasis and the same applies to operations which involve incision and drainage of lung

Excision.—Excision of the diseased segment or lobe or lobes of lung is the one measure that affords an effective relief After a number of years of endeavour during which the mortality was unfortunately high it has become possible to perform lobectomy safely and with as low mortality as any major operation, and with results that can be regarded as extremely gratifying Mortality should certainly not be higher than 3 or 4 per cent. and the recovery rate should lie between 80 to 90 per cent.

The effectiveness of the operation depends largely on the amount of lung tissue that has to be removed. Ideally the removal of one lobe is an eminently satisfactory procedure but if more than one lobe has to be excised the risk of complications increases. Recently bilateral excision has been undertaken with increasing frequency the only problem being to determine how much lung can safely be removed from each side. Life is possible with one upper lobe on each side only but for satisfactory activities removal of more than two lower lobes should be regarded as an operation only to be performed if the symptoms urgently demand excision. In some cases it is also justifiable to do a palliative resection of a grossly damaged area of lung with the knowledge that the surgeon is leaving behind less seriously involved areas which could not by virtue of their situation, be excised In these cases a patient coughing up a considerable volume of offensive sputum and suffering from a severe incapacity may be greatly improved. There is no ban against performing a pneumonectomy or removal of the whole of one lung for bronchiectasis if both upper middle and lower lobes are involved, and this is not an infrequent finding in certain cases of cystic bronchiectasis of long standing

Assessment and Preparation for Operation.—Bilateral bronchograms in which every lobe and segment has been outlined are essential prerequisites. Following these a prolonged period of postural drainage and active breathing exercises should be carried out and the general condition improved to its utmost There is no place for operation without adequate preparation All systems of the body will have to be examined carefully and particular attention must be given to the upper respiratory track to exclude the grosser forms of infection.

The modern operation of lobectomy or segmental resection has altered extensively from the original form of surgery in which the lung root including the vessels, was enveloped by a snare or tourniquet which controlled the vessels while the lung was being roughly amputated after which the projecting stump was secured by sutures and oversewn There were obvious dangers to this type of surgery which has now given place to a deliberate and accurate dissection of each element of the lung root after it has been properly indentified and freed In other words, in the course of a lower lobectomy the lower lobe bronchus is identified and divided close to the upper lobe branch the pulmonary artery and its branches leading into that lobe are then dissected out and secured with thread ligatures next the pulmonary vein or its branches are secured and tied in the same manner and the lung apart from some adhesion at the bottom of the fissure which is always poorly defined will be free In the case of the lower lobe the pulmonary ligament should be divided as a preliminary and at the highest part of this ligament the pulmonary vein itself will be found. The operation has no particular difficulties if the lung is not adherent but often as a result of previous inflammatory changes a vast number of pleural adhesions are present the division of which causes a considerable degree of shock and a certain amount of hæmorrhage Furthermore in some cases the fusion of two lobes together and the absence of a well-defined anatomical fissure raises difficulties, but lung tissue can be cut across, and the raw surface secured and covered over by light suturing. It is not necessary to drain the chest after the majority of lobectomies and a few aspirations during the first week or ten days suffice to remove any accumulation of fluid. Sometimes however it is wiser to use a closed water-seal drain.

The problem of anæsthesia has been partly solved by the introduction of blocking the bronchus or posturing the patient so that movement of the mediastinum and drainage of secretions is not harmful during the course of operation Since these matters have been partly solved the whole aspect of intrathoracic pulmonary surgery has been greatly improved. The average operation may take an hour and a quarter to an hour and a half in fairly straightforward cases but where there are massive adhesions the procedure may be extended to nearly double that time and a considerable degree of shock encountered. For this reason routine blood transfusions are used at operation and all available methods for resuscitation are at hand.

After the removal of a lobe the residual lung tissue in that side of the chest has to expand, or rather to over-expand so as to fill in the whole of the dead space There may be some slight retraction of the diaphragm and mediastinum to the side of operation, but the essential aim towards efficient recovery is that the remaining lung should re-expand and be fully active so that the two sides of the chest are balanced and move practically equally For this reason intensive breathing exercises are most important since any patient will from pain and disinclination naturally tend to restrain full breathing in the post-operative phase In a satisfactory case the residual lung tissue will fill up the empty space possibly within twenty four to forty eight hours In others re-expansion is slower and must be encouraged by breathing exercises and watched radiographically

The Complications of Operation.—The principal complication that follows lobectomy for bronchiectasis is atelectasis or collapse of the residual lung tissue This happens in a high proportion of cases possibly between one third and one-half and is due to inability of that lobe to expel accumulated secretion. In consequence the lobe becomes airless and tends to fall down into the bottom of the chest If the obstruction can be removed by postural drainage and active physiotherapy the lung will aerate but frequently it is

necessary to pass a bronchoscope and aspirate the mucous secretion that has collected after which the lung will start to re-expand Loss of movement of the chest is the most certain sign that such a condition has occurred, particularly if it is associated with shortness of breath The other main complication is bronchopleural fistula resulting from failure of the bronchus stump to heal primarily If a small leak has taken place (and this is usually accompanied by a minor degree of infection) there is a leak of bronchial contents into the dead space and almost certainly some infection of the pleura. This can usually be controlled by aspiration and chemotherapy but if a localised empyema develops, drainage will be needed. In the early days of lobectomy routine drainage to anticipate infection was always practised, but to-day only a small proportion of straightforward cases become infected. Normally a patient is out of bed two to three days after operation, and should be ready to return home within two to three weeks, the chest being completely filled by re-expanded lung

When a segment of lung has to be removed the operation is often much more difficult since the segmental bronchus has to be secured from the depths of the lung tissue and an artificial fissure of lung made by deliberate dissection. This entails a good deal of bleeding and leakage of air from the raw lung surfaces, and the implication of this in the post-operative phase is that these cases will inevitably have to be drained for twenty four to forty-eight hours so as to remove any blood and to prevent the formation of a tension pneumothorax. The treatment of bronchiectasis by lobectomy is probably one of the most satisfactory performances in surgery and it owes much to associated conservative measures of treatment and chemotherapy

GROWTHS OF THE LUNG

Benign Tumours in the Lung are comparatively rare though the so-called *adenomata* of the bronchus are well recognised entities. They possibly arise from the mucous glands in the bronchial wall structure and extend both inside and outside the bronchus They may remain small for a number of years and be completely symptomless, but if they grow inside the bronchus they may give rise to obstruction of that tube with resultant atelectasis or by projecting into it produce hæmorrhage which can be severe and frequent

Some of these tumours can be removed by piecemeal excision through the bronchoscope but in view of their anatomical position a complete cure is hardly likely The introduction of radon seeds in a special intrabronchial carrier has also been used with success as regards the resolution of the tumour but there is usually a later inflammatory stricture which requires excision of the affected area of lung The only satisfactory form of treatment is excision of the lung and tumour If the latter is situated in a lobar bronchus a lobectomy will suffice but if unfortunately it is located in the main stem bronchus a pneumonectomy may be the only remedy Unhappily most of these tumours tend to be central rather than peripheral and require at least a lobectomy for their removal. The essential reason for surgery is that these tumours are progressive they produce collapse with secondary infection and bronchiectasis and in a proportion of cases they certainly undergo malignant change Indeed many authorities regard these tumours as being malignant, and records of metastases have been noted. In a few

selected cases it may be possible to incise the bronchus and remove the tumour locally and then reconstitute the tube but this would only be possible if no secondary changes have occurred in the lung beyond the mass

Other benign tumours of lung have been recorded but are really pathological curiosities Chondroma hæmatoma lipoma angioma neurofibroma have all been listed and they may be diagnosed as a result of their mechanical pressure on the bronchus

Malignant Disease of the Lung has increased greatly during the past few years Some of this increase is undoubtedly due to better diagnostic facilities and the awareness of the frequency of the disease But there has also been an absolute increase so that this form of cancer now ranks only just below that of the breast in its frequency and is already more common than carcinoma of the stomach

Men are affected eight to ten times as often as women and the usual middle age cancer group is that most commonly affected but it has to be recognised that this disease can often occur in people of 20 and 30 *It is regrettable that delays in diagnosis often result from members of the medical profession being unaware that this disease can occur in young and apparently fit people and from the descriptions of cancer of the lung in most textbooks being those of advanced and hopelessly inoperable cases*

Tuberculosis is not associated very commonly with carcinoma if one views the frequency of both conditions and it is not easy to establish any connection between them. The only factor of any relation that has been established is the high incidence of cancer in cobalt mines (Schneeberg cancer) in which the workers are exposed to radio-active chrome Others factors that occur in modern life have been held responsible but there has been no proof as to their direct connection with malignant disease of lung Exhaust gases from motor cars inhalations of dust and above all tobacco smoking have been held as predisposing factors but one can only say that these causes however suspicious have not been proven.

Pathology —A convenient classification of the different forms of pulmonary cancer can be given as follows —

1 The squamous type which occurs largely in big bronchi and gives rise by its extension across the lumen to obstructive symptoms such as collapse and bronchiectasis and even lung abscess These forms can be recognised through the bronchoscope

2 The oatcell type of cancer in which the shape of the cell suggests the name This form tends to be a submucous diffuse involvement slowly obstructing the air tubes but producing in the early stages masses of enlarged regional glands and in consequence is not often suitable for surgical treatment

3 **Adeno-carcinoma,** which tends to be a peripheral and circumscribed type of tumour in the lung field, often causing no symptoms at all for a very long period This group appears only in 10 or 15 per cent of the total the remainder being divided between the squamous and oatcell types

There are numerous variations between these grades and the course of the growths may be extremely slow Symptoms will depend

upon the structures involved and if the growth is extending in a silent area of lung it may have a life-history that extends from eighteen months to two or even three years Acute forms of cancer do occur but generally speaking they are slow-growing and this often contributes to diagnostic errors.

Signs and Symptoms —The features of malignant growths depend on the structures which they impinge upon or involve A growth occurring within a bronchus may obstruct it giving rise to atelectasis, possibly with later infection or even lung abscess. It may press on a bronchus from outside and may induce more gradual forms of obstruction If the pleura is involved *pain* may be an early feature but more usually there is a silent *effusion* which on aspiration may be found to be heavily blood-stained If the *mediastinum* is involved the vagus or phrenic nerves can be affected and the heart and pericardium invaded causing cardiac irregularities. Involvement of the chest-wall is not common the growth tending to spread along the pleural planes rather than to invade the chest wall and appear as a subcutaneous mass.

The earliest symptom is *cough* It is often confused with a post influenzal one or with a smoker s cough which has become a little more troublesome as a result of a cold. If studied carefully it will be found that the intervals between an ordinary coughing habit become shorter and shorter *Sputum* will depend upon the actual lung pathology if there is any inflammation present purulent sputum may be ejected, which certainly will be the case if an abscess or bronchiectatic change has occurred. More usually a scanty mucoid sputum due to irritation is the result and the cough is essentially of an irritating non productive type

Hæmoptysis is a most important symptom and has as its main characteristic a continued staining of sputum for several days on end, this staining remaining bright not gradually tailing off and becoming brown No case of hæmoptysis should ever be ignored for this is one of the most regrettable oversights in diagnosis Pain may result from involvement of the pleura though it is alleged that a deep-seated pain or drag has been described by certain sufferers *Loss of voice* due to pressure on the left vagus or recurrent laryngeal nerve is an important early sign but one which unfortunately usually means that the growth is inoperable Similarly if there is obstruction of the superior vena cava, glandular enlargement can be suspected. The *phrenic nerves* may be involved as they lie on the pericardium causing an elevation and paralysis on one side of the diaphragm a feature that will only be detected on radiography Disturbance of the upper sympathetic chain may give rise to Horner s syndrome and this is usually associated with an atypical condition which is connected with considerable pain. This Pancoast tumour is really a carcinoma wedged in the apex of the lung and since it cannot expand silently early involvement of the brachial plexus and ribs is common.

Shortness of breath depends mainly on the speed with which lung tissue is put out of action A gradual *atelectasis* is not likely to be associated with much disability but a sudden collapse of lung frequently produces shortness of breath and distress A slight degree of pyrexia

may be due to retention of secretions particularly if an inflammatory change in the lung is concerned Loss of weight lassitude and other features of cachexia are not those of an early cancer and one of the commonest misleading features is when a patient taken into hospital may steadily put on weight and improve in general condition even though he has a quite advanced form of growth

Cardiac irregularities in a patient of middle age should always be investigated with the likelihood of a growth extending along the pulmonary veins and involving the auricle Clubbing of the fingers is sometimes associated, and a more exaggerated form pseudo-hypertrophic pulmonary osteo-arthropathy is found in a proportion of cases the remarkable feature of this occurrence being that it is cured immediately after the growth is removed

Metastases from cancer of the lung can be divided into two groups regional and distant The regional glands are situated round the hilum and lung root and then involvement may be regarded as part of the initial clinical picture but distant metastases have a very diverse form Deposits may be found in the axillary or supraclavicular glands but growths in bone in skin and in the suprarenal glands occur frequently Cerebral deposits are also responsible for changes which give neurological signs only in the late stages An altered mentality or slight variation in temperament should arouse suspicion

Diagnosis —The clinical examination is important but the basis of all diagnosis in this condition is radiography when a completely unexpected opacity may be detected. The findings will depend on two factors —

1 The actual growth itself
2 Secondary changes in lung such as collapse abscess formation and so on

A peripheral tumour may be small and rounded looking exactly like a benign and encapsulated tumour More advanced forms of growth fill the whole chest and fluid may add its opacity to that of the original condition If an abscess is observed it can be of two types —

1 An obstructive abscess due to pressure of the growth on a bronchus
2 To an actual breaking down of growth which gives a more irregular edge and a cavity wall of irregular thickness In many cases there is a great difficulty in differentiating an early growth from tuberculosis or chronic inflammatory changes and here the progress of the case for the course of two or three weeks may alone give the correct answer in the absence of more positive signs

Bronchoscopy —Inspection of the bronchial tree is essential in all cases of suspected carcinoma and indeed on rare occasions a growth not observed on X ray can be detected More usually however the tumour may be seen if it is situated in the large bronchi and a fragment removed for biopsy If any abnormality is found careful inspection should be made of the mobility of the bronchus of any distortion or pressure signs that might indicate glands or similar structures that are pressing upon and deforming the air tubes

Bronchography—Bronchography has a very limited place in the diagnosis of bronchial carcinoma and should never be done as a prelude to bronchoscopy which is much more informative except in peripheral forms of growth (Fig 235)

Sputum Examination.—Examination of the sputum for malignant cells is a highly specialised investigation which may produce successful results in the right hands The sputum is examined by the wet-stain method of Dudgeon or by special analysis methods for actual malignant cells that may have been expectorated This examination should never be undertaken within ten to fourteen days of bronchoscopy or any interference with the air tubes.

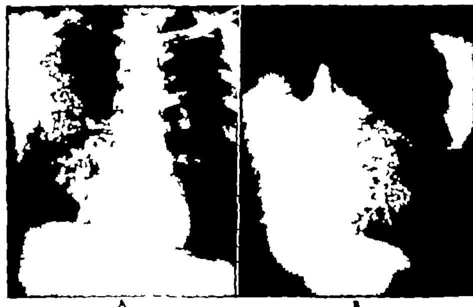


FIG. 235

A bronchogram of adenoma of right lower bronchus (note the lumen is unaltered above the obstruction). B, the appearances of a carcinoma of the bronchus showing the "rat tailed" appearance

Treatment—Following complete investigation and the establishment of the diagnosis of malignant disease only one course of treatment is possible—radical excision. This involves pneumonectomy with a block dissection of all the hilar glands which should be removed with the whole lung (Fig 236) In special circumstances a more limited excision can be done in the shape of a lobectomy but this cannot be guaranteed to give such good long term results. The use of radiotherapy has some symptomatic value but practically none as regards any curative effect. The question of operability depends on the age and general state of the patient and the situation of the growth A young man with a small growth situated in the middle of the lung field is the ideal case for surgery The impossible case is one in which the mediastinum is involved and in which the patient's general condition will not support the loss of one lung Between these lie the majority of cases which have to be selected for surgery

Only about 8 to 10 per cent of all cases of carcinoma of the lung can ever be considered as operable though this figure has been improving during the last few years owing to earlier diagnosis and greater awareness of the danger

In about 40 per cent of all the patients submitted to surgery the condition will be found to be inoperable or not suitable for radical removal. In other words the chest wall or mediastinum may be involved, or there may be glands which though even removed will leave some microscopical tissue behind

Operation.—The operation of pneumonectomy is performed by opening the chest with a long posterolateral incision The lung is then



FIG. 236
Appearance of carcinoma of the lung. A, before; B, after dissection pneumonectomy

freed from adhesions and the pleura stripped away if at all adherent Over the mediastinum a free dissection is made to include the glands, and the individual structures at the hilum are carefully dissected out and secured. These include the main bronchus which must be amputated close to the bifurcation and large pulmonary artery and two large pulmonary veins in addition to numerous minor vessels which are of less importance The bronchus is secured by interrupted sutures and covered either by a pleural or intercostal muscle graft that has been cut at the time of the opening incision Part of the pericardium can be excised if there is any involvement

Specialised anaesthesia blood transfusions and oxygen are administered during the procedure and after operation the two latter can be continued. The effect of the operation is not usually very disturbing constitutionally except in ill-conditioned patients and the *immediate* recovery rate from operation is high, but the possibility of *complications* such as heart failure infection of the dead space or bronchial pleura

fistula give rise to a mortality rate that overall will reach a figure of 12 to 15 per cent In favourable cases the patient is out of bed within the first three or four days and is completely ambulant at the end of ten days, but is kept in hospital until fear of a bronchial fistula has passed in about three to three and a half weeks

The dead space left in the hemithorax after removal of the lung obliterates slowly by the mediastinum and chest wall and diaphragm tending to retract into the space which is also filled by layers of deposited fibrin from the effusion that inevitably collects In the course of six months the whole space may have become almost obliterated, and it is only necessary in cases of infection to perform any kind of thoracoplastic operation to reduce this space The traction on the mediastinum is considerable but is tolerated by patients adequately About 40 to 50 per cent of cases treated by pneumonectomy die at the end of two years from recurrence but they usually do so comfortably Of the remainder more than half who survive operation have a reasonable expectation of life The fairly fit patient who has undergone pneumonectomy should be able to resume his normal occupation so long as this does not involve any very heavy exertions

Endothelioma of the Pleura.—Endothelioma of the pleura is a rare condition which produces effusions frequently blood-stained, and is easily confused with a diffuse pulmonary cancerous spread across the membrane

Sarcoma of the Lung.—Sarcoma of the lung is a relatively rare condition usually rapidly progressive which filling the whole of one side of the chest presses upon the heart and mediastinum and causes death.

Secondary Deposits of Malignant Disease in the Lung.—Secondary deposits of malignant disease in the lung have on occasions been removed accidentally or deliberately There is a possible case to be made out for removal of an isolated single secondary though quite clearly the chance of secondaries in other parts of the body will have to be considered.

Deposits from hypernephroma producing hæmoptysis have been removed with subsequent relief for some period.

MEDIASTINAL TUMOURS

Thyroid.—The extension of thyroid tissue below the upper thoracic inlet is common but in most cases it is not of marked significance though it may give rise to symptoms of difficulty in swallowing or in breathing due to displacement of œsophagus and trachea The plunging goitre is an example of this and at operation this form can usually safely be removed through the ordinary collar incision. The types of goitre that come within the realm of the thoracic surgeon are those that are firmly impacted below the suprasternal notch with marked displacement of the trachea They may have an attenuated attachment with the main mass of the thyroid gland and can even occur as small rounded shadows below the level of the arch of the aorta and posterior to the œsophagus If it is not possible to remove these

tumours through the neck, the sternum can be split down for a short part of its length and the divided pieces strongly retracted This exposes the upper mediastinum and enables the tumour to be delivered.

Thymus.—Enlargement of the thymus persisting into adult life and tumours of that organ are sometimes associated with signs and symptoms of myasthenia gravis To put it in another way myasthenia gravis is often accompanied by an unusual enlargement of the thymus gland or even of a benign tumour In such event the upper mediastinum is explored and the thymus is removed Considerable improvement or even cure of the condition may be achieved In the area of the thymus the proximity of the two pleural sacs and the pericardium will indicate the necessity for the anæsthetist s skill in thoracic work, for though these structures should not be opened during tumour removal accidents may happen but no harm should result so long as their closure is finally completed.

MALIGNANT TUMOURS OF THE THYMUS —Malignant tumours of the thymus are not amenable to surgery but respond readily to deep X ray therapy Unfortunately early recurrence is usual.

Teratoma.—These tumours are congenital in origin arising in the upper part of the anterior mediastinum They may present as simple cysts containing sebaceous material others also benign are semisolid and contain ectodermal elements but there are malignant forms which are rapidly fatal

As these tumours grow they spread from the midline into one of the lung fields and though covered by mediastinal pleura may become adherent to lung Centrally by virtue of their origin they are firmly attached to mediastinal structures. As a result of expansion and pressure a cyst may rupture into a bronchus producing hæmorrhage and the expectoration of sebaceous material and possibly hairs. The signs and symptoms depend on the situation of the tumour which if pressing on a bronchus or trachea would produce cough, and even without this their size filling almost the whole of one side of the chest wall causes shortness of breath Infection of a cyst which ruptures is common

Radiological investigation shows a rounded shadow spreading from the anterior mediastinum into the lung fields Calcification of the walls is common and bone or teeth may be seen There is often transmitted pulsation which can be confused with an aneurysm or other cystic tumours

Treatment —Excision of these tumours should be carried out as soon as they are diagnosed since the procedure is more simple when the tumour is small and not adherent Malignant teratoma respond well temporarily to radiotherapy With a large cyst excision may not be practicable and the relief of pressure sometimes can be obtained by marsupialisation bringing the open cyst walls to the skin surface and producing a permanent sinus The lining can then be treated by caustics

Cysts of the Foregut.—Cysts lined with ciliated epithelium arising close to the trachea—paratracheal cysts—probably originate from the primitive foregut and present as small rounded masses close to the

bifurcation of the trachea. They may contain mucus or chocolate-coloured fluid due to altered blood

Enterogenous or oesophageal cysts arise in close connection with the gullet and may contain elements of gastric and even pancreatic tissue Pharyngeal diverticula are also occasionally found the most common site being in the region of the inferior constrictor muscle

Lymphadenopathy —Lymphatic gland enlargement due to Hodgkin s disease lymphosarcoma or any of the reticulosis group are commonly seen in the mediastinum where they produce rounded X ray shadows and if enlarged pressure signs

Lymphadenoma commonly occurs in the upper mediastinum and is associated with the general signs of Hodgkin s disease though the condition may be localised to the chest for some time

Lymphosarcoma is a more rapidly growing and diffuse mass in the upper mediastinum involving the superior vena cava and producing respiratory distress Both these conditions respond to radiotherapy lymphosarcoma being more sensitive but also being more ready to recur Nitrogen mustard can be injected intravenously and procures some reduction in size of these tumours

Neurofibroma.—Benign tumours arising from the intercostal nerves close to the intervertebral foramina are the most common rounded tumours seen in the chest They may arise from the nerve sheath, from the sympathetic chain or from a posterior root ganglion When they originate within the foramen part of the tumour may lie within the spinal cord and give pressure signs there— dumb-bell tumour These tumours are symptomless unless they produce pressure changes on the ribs or surrounding tissue by their size Radiologically these rounded masses lie in the paravertebral gutter and may be discovered accidentally as a result of routine X ray examination. They should be removed surgically with their capsule as a proportion have been shown to undergo malignant change If left untreated they progressively increase in size

Pleural cysts containing clear fluid lipomata and other simple tumours are occasionally encountered. These are usually removed because of uncertainty in diagnosis

PULMONARY TUBERCULOSIS

The steadily increasing co-operation of physician and surgeon in the treatment of certain types of pulmonary tuberculosis necessitates a short description of the operations used and their indications It is not intended to discuss the etiology pathology diagnosis or treatment of pulmonary tuberculosis in general. These will be found in the text books on medicine

All treatment in pulmonary tuberculosis is directed towards the maintenance of rest of the active lesions so that they will develop the healing phase and become surrounded by fibrous tissue and encapsulation. Rest of the lesion is the basis of the measures included under the general heading of sanatorium regime and treatment But even when the disease process has been arrested or become quiescent certain complications in the actual lung tissue may require some additional

method of treatment The basic aim of most of the surgical measures is to relax the lung so that it can contract down and reduce its size This is in essence a form of splinting which may be compared in principle with the external splinting used in bone and joint forms of tuberculosis During the past two years considerable changes in the approach to tuberculosis have resulted from the introduction of chemotherapy which involves the use of streptomycin and para-aminosalicylic acid (P.A.S.) These drugs have a definite action on the tuberculous process and tend to alter our conception of treatment to some extent but not to the exclusion of basic principles

Pathology.—There are certain aspects of the pathological changes in pulmonary tuberculosis with which surgery is intimately concerned The first of these is the fibrous retraction or contraction of the healing tissue after the active process has become quiescent This *fibrosis* is very powerful and a lesion at an apex for example will pull on the mediastinum and give rise to flattening of the chest and angulation of the trachea or even displacement of the heart

The second important factor is the formation of *cavities* Put in a simple way the cavity is primarily the result of a process of ulceration in the terminal bronchi or alveolar tissue several areas of caseation break down liquefy and form small ulcerated cavities these coalesce and produce a single irregular ragged cavity of varying size There is also in addition a good deal of endobronchitis or narrowing of the bronchi whereby air tends to become trapped within the ulcerated area without free egress As a result this steady increase of air within the cavity leads to its distension to the spherical form which we recognise as a round cavity in the X-ray picture

It is with this fibrosis and cavitation that surgery is intimately concerned If disease is active the place of surgery is limited since interference at this stage may result in further exacerbation but when it is estimated that the disease has become more or less arrested and a residue of fibrosis and cavitation remain to be dealt with, the possibilities of surgery are obvious

In addition to the symptoms caused by the presence of fibrosis and cavities there is continued risk if they persist because with an open cavity the chances of further extension of disease at some later date is very real. Therefore wherever possible cavities should be closed or obliterated and fibrotic retraction should be reduced If cavities are successfully closed a patient who is expectorating tubercle bacilli may become a closed case and lose all the symptoms attributable to the disease and so become arrested or quiescent

PRINCIPLES OF TREATMENT.—Relaxation of lung may be obtained by two main methods, viz. by admission of air into the closed pleural cavity or by reducing the size of the thorax itself

In the first instance air is gently admitted into the pleural cavity and a pneumothorax is produced the lung retracting by its own elasticity The diminution in lung volume *reduces the size of the cavities* which tend to close This artificial pneumothorax is an extremely valuable form of treatment but the absence of pleural adhesions is essential to its success.

The second main principle reduction in size of the thorax itself, is obtained either by removal of ribs (thoracoplasty) or paralysis of the diaphragm by crushing or division of the phrenic nerve Excision of cavitated areas by lobectomy or pneumonectomy may be included in this principle of treatment

Selection of the appropriate measures demands the closest co-operation between physician and surgeon in all stages of the patient's actual illness convalescence recovery and future One procedure may tide him over one particular phase at another stage different perhaps more permanent measures may be required to obtain a more efficient degree of rest and relaxation

The types of operation will now be enumerated and their spheres of usefulness briefly indicated.

Artificial Pneumothorax.—When air is introduced into the pleural cavity the elastic lung retracts from the chest wall and if no adhesions are present the tuberculous affected area will contract and stay in that condition while the process of healing proceeds.

Air however tends to be quickly absorbed from the pleura one filling is not adequate and once the pneumothorax has been established refills have to be given at intervals of one two or three weeks and to be continued for a period of three to five years if ultimate healing is to be obtained.

The operation of refilling is simple air is injected through a special needle and control of the amount of air introduced into the pleural cavity is checked by manometric measurements, which are recorded on each occasion. The operation has the advantage of being flexible in character and can be abandoned quickly should any untoward event arise The main complication is effusion into the pleural cavity This may be transitory but it may result in fusion of the pleural layers and obliteration of the pneumothorax space and even of the production of a tuberculous empyema which is a serious complication. It is certainly the most simple procedure available but it has to be selected with as much care as the more major operations.

Thoracoscopy and Division of Adhesions.—In many cases of artificial pneumothorax collapse of the lung cannot be complete on account of adhesions between the lung and the chest-wall. If these adhesions are long and thin they can be divided with an electric cautery visualised through a telescope but if there are many or massive adhesions the chance of freeing the lung from the inside of the chest wall is small. The operation consists of introducing an endoscope (a light and telescope) and through another incision an electro-cautery to divide the adhesions. The cautery is required to arrest any bleeding in the actual adhesion itself and may be required on occasions to arrest more vigorous hæmorrhage from an intercostal vessel or even a mediastinal one Considerable judgment and experience are required in this operation for the reasons mentioned to know how much can safely be done without producing a sharp pleural reaction, effusion and even an empyema. Moreover in the rare event of a large hæmorrhage occurring the surgeon must be ready to do a thoracotomy to control the bleeding point. Many cases of pneumothorax require this operation to make the collapse of the lung effective and to obtain retraction of the diseased area.

Extrapleural Operations.—Diaphragmatic Paralysis.—If a phrenic nerve is divided or crushed paralysis of that side of the diaphragm will result, and the dome of the diaphragm will ascend into the chest and reduce the size of the thorax to some extent. The effects of the elevation is most marked on the middle and lower parts of the lung and less towards the apex.

In consequence the lesions in the lower parts of the lung are more suitable for this form of operation than those higher placed

The operation consists in exposing the phrenic nerve in the base of the neck just above the clavicle where it is crossing the scalenus anticus muscle The common practice is to crush the nerve which results in its paralysis for a period of four to six months, and if after regeneration further paralysis is required, the nerve can be crushed again The operation is only partly effective by itself but if used in conjunction with other procedures notably pneumoperitoneum it may be of considerable value It should be regarded as a temporary supplementary operation and it has the merit of being one which runs no risk of producing any pleural reaction.

PNEUMOPERITONEUM.—Injection of air into the peritoneal cavity is a procedure that is now frequently performed It follows the same principles as pneumothorax with regular refills the effect of the air within the abdominal cavity being to force the diaphragm up into the chest If this is combined with phrenic paralysis a considerable elevation of the dome of the diaphragm may be achieved, and it is a form of collapse of great use if other measures are not deemed suitable It is also of value if a "damping-down" of the tuberculous process is required before a more permanent measure of collapse is contemplated

EXTRAPLEURAL PNEUMOLYSIS.—If the two pleural layers are firmly adherent it is possible to free them from the deep surface of the ribs by blunt dissection in the plane of the endothoracic fascia. This is often seen at post mortem when the lungs are being torn from the thoracic cage and a bare area is left by both areas of pleura being stripped away Surgically the operation is carried out by the removal of a short length of rib and then pushing away the adherent pleural layers under the ribs and carrying out this blunt dissection over the apex and across the mediastinum down to the roots of the lung. The whole apex of the lung is freed as far down as the 4th rib in front and the 9th or 10th rib behind producing a large dead space and considerable collapse of lung This collapse however is not maintained by itself as the lung tends to re-expand, and the pneumolysis has to be maintained by using —

1 Refills of air—*extrapleural pneumothorax*—on the same lines as in artificial pneumothorax but using a very much greater degree of pressure

2. By introduction of some inert substance such as a polythene pack, which consists of a polythene bag filled with strips of the same material, or using plastic balls made of lucite or some similar inert substance The effect of the blunt dissection and the extensive raw space is to produce a copious serous and bloody exudate which has to be aspirated. Once this has been achieved either refills can be continued for a space of a year or eighteen months or the operation can be considered as concluded if plombage filling has been used The disadvantage of pneumolysis is that the fills have to be maintained which is not always easy Also if the operation involves foreign materials there is a possibility of their ulceration into lung The extrapleural procedures have a certain sphere of utility when more permanent types of procedure such as thoracoplasty are not considered advisable

Thoracoplasty.—If the ribs are removed from the chest wall the underlying lung will collapse and remain collapsed. The usual form of thoracoplasty is directed at collapse of the apex of the lung and involves removal of the upper six or seven ribs with an apicolysis or complete freeing of the apex of lung after the ribs have been removed. In this way a concentric collapse is

pneumonectomy in certain selected cases of pulmonary tuberculosis With the use of chemotherapy and modern surgical technique success can be obtained in a high proportion of cases Though some schools of surgery are enthusiastic about excision the usual attitude at present is that excision in no way replaces collapse therapy but should be used where collapse is not practicable

Selection of Cases.—As will have been gathered from the variety of operations that are used, a selection of the appropriate treatment for the particular patient is not a simple matter and indeed in few instances is the position quite straightforward. The ideal case for collapse therapy is a small cavity at one apex surrounded by a minimal amount of disease and a minimal amount or nothing on the opposite side This state of affairs is however rare and it is frequently found necessary to try one form of collapse therapy at one time and then to follow it later with a more permanent form, and in many cases to undertake bilateral treatment such as pneumothorax on one side with a thoracoplasty on the other The tuberculous process is an ever changing picture and the operations must be selected and chosen according to the phase and activity of the patient s disease

Tuberculous Pleural Effusions.—The most simple involvement of the tuberculous pleura is a dry pleurisy recognised clinically as a rub without the formation of much fluid more frequently however as a pleural effusion following a primary complex or occurring as a secondary process usually in the course of artificial pneumothorax treatment These conditions require little active treatment unless there is a large accumulation of fluid which interferes with lung function, and it then can be aspirated.

The more difficult types of effusion are those which after becoming turbid as a result of cellular exudate and probably the presence of tubercle bacilli, turn into frank pus. At this stage it is almost certain that there will be tuberculous granulation tissue in the pleural membrane When this occurs fibrin is laid down from the effusion and this cicatrises over the lung surface and chest wall and forms a rigid constricting membrane Treatment should therefore aim at early expansion of lung before it has become too bound down. This can be achieved in the early stages by frequent and complete aspirations and in most cases even though there is disease in the lung it is worth risking the effect of the re-expansion of the diseased area to obtain obliteration of this extensive tuberculous granulated area At the completion of each aspiration the introduction of streptomycin probably helps in arresting the local disease Should, however aspiration fail to re-expand the lung a chronic dead space will be left and sooner or later the abscess will rupture into lung causing a bronchopleural fistula with flooding of the lung with tuberculous pus or it may track outwards through the chest wall to form a subcutaneous cold abscess and later multiple fistulae In this case two alternatives are open one is to perform an extensive thoracoplasty and allow the chest wall to fall in against the lung the second is a more drastic procedure requiring the removal of the lung and pleura intact—a pleuro-pneumonectomy The severity of these operations is indisputable but the condition produced by a chronic purulent tuberculous empyema is one that is fraught with many dangers

SURGERY OF THE HEART

The rapid development of cardiac surgery has brought a number of conditions within the scope of practical surgical application These include surgery of the pericardium surgery of certain forms of congenital heart disease and the surgery of cardiac valvular disease

achieved and the extent of the operation can be made appropriate to the extent of the disease in the individual patient

The modern operation consists in removing the ribs in two or three stages. At the first stage the upper two ribs and the back ends of the 3rd and possibly 4th are excised and an extensive apicolysis performed Two to three weeks later a second operation is carried out and the anterior ends of the 3rd and 4th ribs with additional lengths of the 5th, 6th and 7th are removed This latter procedure can be carried out in two stages if necessary The incision, which is made posteriorly between the spine and vertebral border of the scapula, involves division of all the muscles holding the scapula to the chest wall At the completion of the second stage the



FIG. 237
Right-sided pulmonary tuberculosis of the upper lobe.
A, before ; B, after partial thoracoplasty

scapula usually falls in against the dead space that has been formed and helps to obliterate it It is an extensive procedure and requires all the help that modern surgery can give in the way of preparation, post-operative physiotherapy and the like The advantages are that it is a permanent operation, tailor made to the individual case and assurance can safely be given that practically no deformity will follow a well treated case (Fig 237) Many modifications are used and recorded, but the principle in all is the same i.e resection of ribs and apicolysis to obtain a concentric relaxation. The mortality of the operation is below 5 per cent and the results are satisfactory in that about four fifths of the patients obtain an excellent result.

Cavernostomy—A very large cavity apparently impossible to treat by any collapse therapy may be drained either by the insertion of a small tube and cavity suction drain or by a formal cavernostomy in which the cavity is laid widely open and allowed to granulate The operation has a limited field, but the application of streptomycin to the interior of the cavity itself has led to some excellent results

Excision of Lung.—Until recently it was considered bad practice to attempt excision of tuberculous lung owing to the dangers of exacerbation of disease but during the past few years it has been possible to perform lobectomy or

pneumonectomy in certain selected cases of pulmonary tuberculosis With the use of chemotherapy and modern surgical technique success can be obtained in a high proportion of cases. Though some schools of surgery are enthusiastic about excision the usual attitude at present is that excision in no way replaces collapse therapy but should be used where collapse is not practicable

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is thus deflected into the lungs and oxygenated To all intents an artificial ductus arteriosus is constructed and the fistula allows a greater sphere of activity to the patient even though it is obvious that the operation though relieving does not cure the cardiac condition The operation requires a high degree of technical skill and in experienced hands has a mortality of 10 or 12 per cent The results, however are extremely gratifying in the amount of activity that is allowed to these patients who are otherwise doomed to a complete disability and a probable early death. The operation has, however not been performed for a sufficient number of years to assess the absolute end results.

An alternative to the anastomotic type of treatment is a direct attack or approach on the valves or stenosis which is carried out by incising the interior wall of the right ventricle and introducing a valvotome or punch to widen the opening and make some effort towards *restoring the normal condition*

A number of other operations on the heart have barely passed the experimental stage but the approach to the mitral valve and its division has been seriously considered and carried out successfully in a number of clinics. The treatment of mitral stenosis consists in either dividing the valve after approaching it through the left auricular appendix or by affording a venous shunt between a branch of a pulmonary vein and a systemic vein *e.g* the azygos so that the raised pressure in the pulmonary circuit can be deflected and the strain on the heart thereby removed

Greater developments in cardiac surgery may be anticipated during the course of the next few years, once certain procedures have passed the experimental stage

T Holmes Sellors.

CHAPTER XXV

THE BREAST

ANATOMY.—The breast lies in the subcutaneous tissues covering the chest wall. In its fully-developed virgin state it is roughly hemispherical, and extends from the 2nd to the 6th rib and from the edge of the sternum to the mid-axillary line It has a well-defined prolongation along the lower margin of the pectoralis major muscle the axillary tail, which extends into the lower part of the axilla. It lies mainly on the pectoralis major muscle but overlaps on to the serratus magnus and abdominal external oblique muscles It is ensheathed by the superficial fascia which splits to enclose it and from the laminæ thus formed fibrous processes spread into the gland to support its lobes. From the anterior lamina, particularly in the upper half fibrous strands extend to the skin and are known as the suspensory ligaments of Cooper Just below and internal to the centre of the gland is the nipple placed in the middle of a circular area of pigmented rugose skin—the areola, the surface of which is studded with numerous small projections due to specialised sebaceous glands the follicles of Montgomery The summit of the nipple is perforated by the orifices of the lactiferous ducts. The breast is composed of from fifteen to twenty lobes each of which is pyramidal with its apex at the nipple Each is complete in itself and consists of lobules of secreting tubules, and is drained by one main duct viz. the lactiferous duct which on approaching the surface dilates to form an ampulla and then narrows again to reach the nipple. After lactation the breast loses its firm compact structure and becomes more fleshy more bulky and more pendulous After the menopause its tubules atrophy and it becomes shrunken.

The blood supply is derived from the external mammary branch of the axillary the internal mammary artery and branches from the intercostal arteries of those spaces over which it lies. The venous return is to the axillary and internal mammary veins.

The lymphatic drainage may be divided into four groups —

(a) A central subareolar plexus the efferents of which pass to the pectoral group of axillary glands

(b) The outer and lower quadrant drains into the central axillary glands some channels passing direct others going to the pectoral group first

(c) The upper and outer quadrant drains into the axillary glands via the pectoral group while some lymphatic vessels pass direct through the costocoracoid membrane

(d) The inner quadrants efferents penetrate the intercostal spaces to enter glands along the internal mammary vessels

The development of the breast is from a small circular thickening in the epidermis of the chest wall during the second month of intra uterine life From the deep surface of this area solid columns of cells make their way into the subjacent tissue and then produce lateral offshoots The main

columns are the future lactiferous ducts and from the lateral offshoots are formed the lobules and acini The surface cells of the thickened area develop into the nipple and areola The breast remains in this rudimentary state until puberty when great activity occurs and the secreting tissue is fully developed

Anomalies in Development

These may be classified as
- Anomalies in number—Deficiency i.e amazia.
- Excess i.e polymazia.
- Anomalies in situation
- Anomalies in function.
- Anomalies in size

There may be complete absence of one or both breasts known as *amazia* or an absence as well of nipple and areola a condition termed *athelia* *Polymazia* means the presence of additional breasts on the anterior surface of the body along a line drawn between the midpoint of the clavicle and the pubic spine a state of affairs normally seen in certain animals *Polythelia* is a similar condition in which nipples without breasts are found. In addition supernumerary breasts are recorded in many parts of the body *e.g* the labium majus and the outer surface of the thigh Anomalies of function include absence of secretion in women after delivery and that rare condition in which the male breast has secreted milk

Anomalies in size are illustrated by *hypertrophy* infrequently seen in young women. It is usually bilateral and the breasts grow to great size causing embarrassment not only by their dimensions but by giving rise to pain dyspnœa and palpitations It may occur as an unrestrained overgrowth during pregnancy but is most common in young non pregnant women. The change is mainly a hyperplasia of the fibrous tissue and not of the glandular elements Treatment is some form of plastic operation or complete amputation.

Gynæcomastia is the term applied to the development of the breast in the male in whom at puberty an abortive attempt to form a breast normally takes place This is represented by a slight enlargement beneath the areola and some throbbing and tenderness This stage may give rise to parental anxiety but the activity soon ceases and the swelling subsides In rare cases growth continues and a small virgin breast is formed on one or both sides It may be thought difficult to justify an operation, but it is better to remove the breast than that the boy should be the subject of so definitely embarrassing an anomaly

Clinical Examination of the Breast

The breast is first examined by inspection for which purpose the patient should be sitting up in bed or in a chair so that both breasts are available for comparison Swelling shrinkage or deformity of the breast is apparent as also are abnormalities of the nipple or areola and invasion and fixation of the skin For palpation the patient is placed flat on the back in bed and the observer sits beside her on the

affected side The physical characteristics of any tumours are investigated by palpation with the flat of the hand and between the fingers and thumb Its mobility is determined with regard to the breast tissue the skin and the underlying deep fascia If the swelling is surrounded by the fingers and thumb of the left hand and moved about by the right index finger then if it is attached to any part of the breast tissue a pull will be communicated to each finger in turn as the tumour moves If however it is free and unattached to the breast it will move so freely as to communicate no pull on the surrounding fingers Surface fixation may be demonstrated by attempting to lift the skin or to make it slide across the tumour In testing for fixation to the deep fascia, the underlying muscle must first be put into action and the tumour tested for mobility along the long axis of its fibres The pectoralis major is rendered taut by the patient placing the hand on the iliac crest and pressing strongly against it the serratus magnus is put in action by instructing the patient to touch the back of the head which movement is resisted by the observer The axillary contents are then examined and the number size position, consistence and fixation of any enlarged glands noted. And finally before any opinion can be given, the spine supraclavicular triangles opposite breast and axilla abdomen and chest must be examined for the presence of secondary growths

DISEASES OF THE NIPPLE AND AREOLA

RETRACTION OF THE NIPPLE

This may be congenital in that the adult prominence is not developed and the position of the nipple is marked by a pit in the centre of the areola (inversion of the nipple) This may lead to difficulties in suckling and predispose to infection Acquired retraction is a classical sign of carcinoma of the breast but can occur in any condition leading to scarring within the breast such as a breast abscess

SIMPLE ECZEMA

This is typical of eczema as seen in other parts of the body and is caused by the *Staphylococcus aureus* It occurs at any age after puberty and is often associated with lactation. It yields readily to treatment and is of importance only if it complicates lactation, in which it may act as the starting point of an acute mastitis. Apart from this it makes suckling a matter of doubtful propriety as the milk is heavily infected, and any applications to the eczema will further contaminate the milk

Treatment consists in applications of penicillin cream and exposure to the infra-red lamp Before suckling, the area must be carefully cleansed and a nipple shield used In severe lesions the child should be weaned In those cases occurring apart from lactation mild mercurial ointments will readily effect a cure Cracks and fissures follow injury during suckling due to failure to harden the nipple

during the last month of pregnancy If this is done and retraction corrected the nipple should be able to withstand the pressure of the infant's alveolar margins Proper hygiene both before and after delivery should ensure the complete absence of cracks and fissures, and so do away with the chief etiological factor of breast infections

PAGET'S DISEASE

This is a chronic persistent eczematous condition which does not yield to treatment and which is associated with a carcinoma of the breast

It occurs in elderly women rarely before 50 years and is always unilateral. It has been described in men.

Naked-eye Appearance.—A small area on the nipple or areola is affected by a papular eruption, which soon breaks down and spreads over the whole areola and later to the surrounding skin In time the process being a slow one the nipple and areola are destroyed and are replaced by a condition resembling simple eczema The colour is a particularly vivid scarlet on a granular surface with little points of pus oozing from it The edge of the skin is thin purple and well defined. Some cases have crusts over the whole or part of the area, and the typical appearance is seen only on removing these (Fig 238).



FIG. 238
Paget's disease of the nipple

Microscopic Detail—There is a proliferation of the epithelium with desquamation of the surface layers and a dense round-celled infiltration of the corium with increased vascularity In the surface epithelium certain cells undergo swelling and vacuolation forming Paget bodies (Fig 239) The ducts may be dilated and their lining membrane shows some proliferation (Kettle)

The Nature of the Condition—In the original description it was accepted that carcinoma developed at some period as a result of the chronic inflammatory lesion in the skin. Sampson Handley however holds *that the carcinoma exists previously in the breast and is* the cause of the eczema He has shown that a small atrophic scirrhus may cause sufficient lymphatic obstruction to bring about a water logging of the skin a shedding of the surface epithelium and the production of the typical appearance. It may be years before the growth is clinically recognisable and it is not always in that part of the breast immediately subjacent to the areola. His theory is accepted to-day and treatment is based upon it.

Treatment—In the face of an eczema of short duration and without a palpable tumour doubt may exist as to the nature of the

condition In such cases the usual treatment for simple eczema should be adopted but if no improvement has occurred within one month the diagnosis of Paget s disease is established If no tumour is palpable a resection of the breast disc with an elliptical area of skin is sufficient but if the growth can be felt the radical operation should be performed.



FIG 229

Microscopic appearance of Paget s disease

1 is the hypertrophied epithelium showing 2, Paget bodies, and 2, the subepithelial zone of round-celled infiltration and congestion. (*Kettle.*)

DISCHARGE FROM THE NIPPLE

A serous discharge from the ducts may be present in duct papilloma duct carcinoma and rarely in chronic mastitis No abnormal condition may be palpable though careful examination may prove that the discharge is produced by pressure over one isolated segment of the breast and always from the same orifice A persistent discharge is always to be regarded as of great importance as suggesting a probable duct papilloma and treated accordingly

A blood-stained discharge is not necessarily a sign of a malignant process but the same importance will attach to it as to a simple serous discharge

DISEASES OF THE BREAST

ACUTE MASTITIS

Mastitis Neonatorum is a condition seen occasionally in infants after birth when one or both breasts become slightly swollen and tender only rarely will suppuration ensue in which case an incision will be needed Apart from this no treatment is required

Mastitis of Puberty is not an inflammatory process At puberty the secreting part of the breast is developed and its growth to normal young virgin size is rapid When this occurs simultaneously on both sides the condition is rightly regarded as normal but not infrequently the development of one breast precedes the other As some tenderness and throbbing will be present the girl may be brought for advice A simple explanation of the facts suffices In boys a transient abortive effort at breast growth may also require similar sympathetic explanation.

Acute Mastitis in the Adult. *Etiology*—The great majority occur during lactation, the remainder being due to spread from surface infection suppurating hæmatomata or to pyæmia During lactation there are certain predisposing factors such as retracted or soft nipples which may give rise to cracks and fissures and *when these have occurred, only* the most meticulous cleanliness will prevent infection spreading into the breast The infection which is usually staphylococcal, travels either along the lymphatics in the interstitial planes or rarely along the ducts Three stages in the process may be recognised

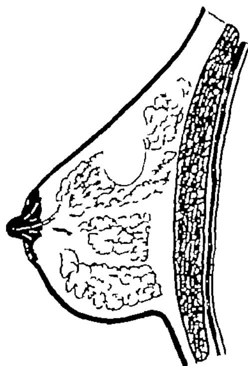


FIG. 240

Diagram illustrating the three types of breast abscess. The breast is seen in section lying upon the pectoralis major muscle and chest-wall. Nipple and areola in red, fat in yellow breast acini in grey Abscesses in green, subareolar intramammary and retromammary

A **Milk Engorgement** is a condition best exemplified by the cessation of suckling as when the child is weaned or kept from one breast for some local reason. The whole gland is then swollen, firm and tender and throbbing pain may become severe. It occurs also as the first stage of breast infections and affects either the whole organ or certain lobules only The infection causes an inflammatory reaction around the ducts and also a swelling of their lining membranes The flow of milk from these ducts is obstructed, and milk engorgement occurs in the lobules drained by them. A sector-shaped area of induration appears which is throbbing and tender The use of the breast is possible but distinctly painful. There will be slight malaise and the temperature will be about 99 to 100 F

B **Acute Non suppurative Mastitis.**—If the condition of milk engorgement is not relieved the infection will progress deeper into the lobule and the acini filled with stagnant milk afford an admirable culture medium for the infecting organisms The affected area becomes more indurated, more definitely localised and the pain throbbing and

tenderness increase The skin will be hot and red and enlarged veins will be seen coursing over the breast The temperature is up to 101 to 102 F and the patient is now definitely ill

C **Acute Suppurative Mastitis or Breast Abscess.**—The condition changes only in that softening occurs in the centre of the indurated area and fluctuation becomes apparent. The general condition of the patient rapidly deteriorates Three types of breast abscess are described according to their position (Fig 240)

1 The *premammary* (or subareolar) abscess occurs when the infection remains localised around the main ducts beneath the areola. The skin is early involved and the pus remains superficial

2. The *intramammary* abscess is the usual type in lactational mastitis It is commonly limited to one or two lobes a sector shaped area of induration resulting but the whole breast may be affected There is a tendency particularly in deep-seated abscesses for the pus to track, which results in a loculated cavity (Fig 241)

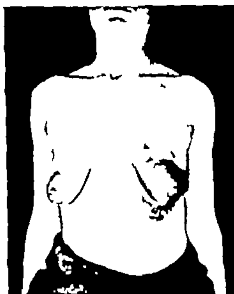


Fig 241

A long-standing lactational infection of the left breast, accompanied by external eczema of the skin.

3 The *retromammary* abscess occurs behind the breast and often behind the deep fascia. It is due to infected hæmatomata or rarely to a neglected empyema spreading through the chest wall. A chronic abscess in this position is due to tuberculous disease of the ribs These abscesses give a very characteristic clinical picture the breast which is normal, is pushed forward and appears to be floating on the surface of a fluid cushion

Treatment —Acute mastitis during lactation is due to neglect and uncleanliness and should therefore never be allowed to occur Efficient antenatal care and proper attention after every feed would succeed in abolishing breast abscesses altogether

The treatment of milk engorgement during the weaning of the child needs no description here When it is due to cracked nipples or threatened infection the first decision concerns the continuation of milk secretion If the usual time for weaning is near at hand if the supply has never been good and the child is not thriving or if the mother's condition is poor then lactation should be terminated If however the mother is strong and the infant is only a few weeks old and thriving well every effort must be made to preserve the milk supply The child will be confined to the unaffected breast and any deficiency made good by one or two bottles The affected breast must

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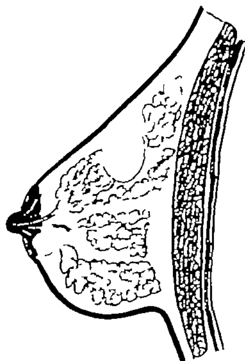


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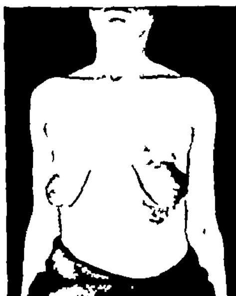


Fig. 241

A long-standing lactational infection of the left breast, accompanied by extensive eczema of the skin

3 The *retromammary* abscess occurs behind the breast and often behind the deep fascia. It is due to infected hæmatomata or rarely to a neglected empyema spreading through the chest wall. A chronic abscess in this position is due to tuberculous disease of the ribs These abscesses give a very characteristic clinical picture the breast which is normal, is pushed forward and appears to be floating on the surface of a fluid cushion.

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be emptied *completely* every four hours by a breast-pump and in the intervals swathed in hot dressings and firmly supported. The patient should be kept in bed and adequately but not severely purged.

With the onset of acute mastitis the same treatment is continued and systemic penicillin therapy instituted. The desirability of weaning the child becomes more urgent and a careful watch is kept for signs of suppuration. When pus forms a radial incision must be made and the pus evacuated. Aspiration and penicillin replacement have proved disappointing. Retromammary abscesses are drained by a curved incision below the breast in the line of the skin reflection on to the chest-wall.

CHRONIC MASTITIS

Etiology.—Chronic mastitis of inflammatory origin is known to follow the incomplete resolution of an acute mastitis. Clinically it is indistinguishable from chronic interstitial mastitis but the history of previous infection and a small round-celled infiltration define the latter sharply from the former. The term chronic mastitis is commonly restricted to the non inflammatory condition.

The etiology of such chronic mastitis is imperfectly understood. Infection has no part in its causation and it is probable that it is the result of a disturbance of those endocrine factors which control the activity of the mammary epithelium. From puberty to menopause the female breast is in varying stages of activity. Apart from pregnancy the breast epithelium undergoes proliferation and regression during each menstrual cycle. At the menopause widespread atrophic changes occur. Functional activity is known to be influenced by both ovarian hormones œstrin and lutein which are under the control of the anterior pituitary hormones. These latter may also possibly exercise direct control upon the breast epithelium. Repeated injections of œstrin will produce chronic mastitis in experimental animals. It seems probable therefore that some error in hormonal control plays a leading part in the causation of this disease. It does, however, occur in men, and in both sexes it is known to follow direct injury to the breast. The variety of the microscopic appearances suggest that many influences are at work, and at present the etiology remains obscure. It occurs most commonly during the years immediately preceding the menopause but is not infrequent in young women following injury. The incidence is slightly higher in women who have borne children, and miscarriage seems to be a predisposing factor.

Naked-eye Appearance.—A cross-section shows a thickened area of breast tissue, dull ivory white in colour with or without cysts. When present these vary in size and number: sometimes one large cyst dominates the picture while in others multiple small cysts are scattered throughout the tissue. They are filled with a brownish fluid and when exposed have a blue colour giving rise to the name "blue-domed cysts" (Fig. 242).

The Microscopic Appearance is very complex. The condition so well defined clinically includes widely differing cellular changes. Essentially there is a proliferation of interstitial connective tissue

leading to interference with the acini and their ducts some of which may become occluded causing the acini to distend behind them and form cysts The epithelium reacts in different ways In some cases the acini are so compressed that they undergo atrophy and slit like spaces lined with a flattened epithelium are seen lying in a dense mass of fibrous tissue In others the epithelium proliferates filling up and distending the acini In many specimens these two processes of atrophy and hyperplasia occur side by side

Relationship to Carcinoma —Considerable conflict of opinion exists concerning the precancerous status of chronic mastitis Some observers deny the existence of any etiological association which has undoubtedly been exaggerated in the past Nevertheless it is wise to regard chronic mastitis as a possible if infrequent precancerous condition.

Clinical Features —In young women a history of injury often during some game will be obtained. In all the earliest and only symptom is pain At first it may be merely discomfort but later a dull aching pain becomes constant Its severity varies widely in different patients It may be felt in one segment only or referred to the whole breast and occasionally shoots up into the axilla and down the arm It is worse just before and during the menstrual period and is aggravated by severe work or exercise entailing prolonged use of the pectoralis major muscle If the patient notices a lump in the breast it is because her attention has been directed to it by the pre-existing pain.

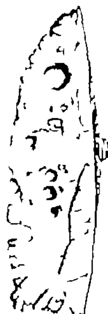


FIG. 24
Chronic mastitis with multiple cysts.

The findings on palpation depend on the degree of cyst formation. Chronic interstitial mastitis without cysts produces one or more indurated lumps in one or both breasts The mass can hardly be felt with the flat of the hand but when it is picked up between finger and thumb a coarse or knotty feeling can be appreciated as if a ball of inextricably tangled thick string were being palpated beneath the skin The presence of cysts of small size makes the nodular feeling more pronounced and a single large cyst forms a definite tumour surrounded by typical mastitic tissue. More rarely the condition may be limited to one or more contiguous lobes when a sector-shaped wedge of induration results This is described as chronic lobar mastitis In all cases the indurated areas are tender

Diagnosis —The non-cystic mastitis can never be mistaken for anything else once its typical feeling has been learnt the occasional case of tubercular mastitis providing the only difficulty But the cystic type may readily be confused with carcinoma and less frequently with fibro-adenoma The diagnosis of a cyst can be quickly verified by aspiration (see p 528)

Treatment —The possibly precancerous character of chronic mastitis has some bearing upon treatment. In young women it is never

justifiable to waste time on palliative measures and a course of X ray treatment is begun at once Its results are excellent in early cases, but in those which fail to respond an excision of the indurated area must be advised In older women, in whom no cysts can be felt and no doubt exists as to the diagnosis treatment is symptomatic Pain is often relieved by a course of X ray treatment and the breasts need firm support The use of synthetic œstrogens is advised in some quarters. Their use however is not without danger as they have been proved in laboratory animals to possess carcinogenic powers In mild cases the breasts must be properly supported by a really well-designed brassiere and never allowed to hang down If no improvement takes place if the pain is said to be intolerable if cysts are present if any doubt as to *the diagnosis exists and if the patient is consumed with the fear of* cancer (which is often the case) then an operation should be performed If the area is strictly localised a local excision of the lump may suffice but if as is often the case the condition affects the whole of the breast the breast disc should be removed.

CHRONIC NON TUBERCULAR ABSCESS

This condition is occasionally seen as the result of a low-grade infection in a hæmatoma in a previously existing retention cyst, or in connection with an imperfectly resolved acute mastitis which did not form an acute abscess at the time It forms a slowly increasing swelling which is painful and tender The breast is enlarged and pushed forward, and there is an indurated area occupying a large part of the organ The thickness of its wall may make fluctuation difficult to obtain, and this may be so misleading as to suggest a rapidly growing carcinoma The entire abscess with its walls should be dissected away if possible otherwise it is opened and drained

TUBERCULOUS MASTITIS

Etiology—Tuberculous infection of the breast is rare It occurs between the ages of 20 and 35 is unilateral and in over 60 per cent of cases is secondary to a known infection elsewhere *e.g* the cervical or axillary glands or lungs It may reach the breast by the blood stream the lymphatics or by direct spread It has been reported as having spread from the nipple but has never been known to occur in men.

Pathology—At the beginning the disease is limited to one or two lobules, the acini being surrounded by tuberculous granulation tissue. More fibrosis is seen in the breast than is common in tuberculous lesions elsewhere The process slowly spreads caseation occurs in the centre and later multiple abscesses are formed with walls of typical tuberculous tissue surrounded by dense fibrosis Eventually a small shrunken breast results with several sinuses

Symptoms—Dull, aching pain first calls attention to the breast of a patient who has usually had a history of tuberculosis elsewhere The clinical signs fall into three stages First there are areas of induration impossible to distinguish from those of chronic mastitis Secondly the fibrosis has increased to such an extent that the tumour is very hard, the nipple retracted and the skin fixed while enlarged

axillary glands may be felt The mimicry of carcinoma is complete In the third stage caseation and possible sinus formation reveal the true nature of the condition In most cases the diagnosis is not difficult if care is taken to obtain a proper history nevertheless it provides many mistakes

Treatment —Streptomycin will give good results but it must be combined with calciferol to achieve a lasting cure This regime consists in giving 1 g of the former for fourteen days and 1 mg of the latter daily for six weeks (but not longer)

SYPHILIS OF THE BREAST

This is very rare A primary chancre of the nipple and areola may be seen and condylomata occur on the lower part of a pendulous breast close to the line of reflection of mammary skin on to the chest wall Gummata are occasionally met with forming dense areas of induration which become fixed to the skin and later break through to form a typical gummatous ulcer

ACTINOMYCOSIS OF THE BREAST

This is also very rare It may reach the breast by direct implantation by spread from the pleura or by a blood-stream infection It produces one or more areas of induration and is indistinguishable from chronic mastitis until it breaks down and involves the skin when the typical yellow granules in the discharge reveal the nature of the condition.

FAT NECROSIS

This interesting condition is not so rare as is generally taught It is invariably the result of injury which is usually in the nature of a direct blow but which less commonly is indirectly communicated to the breast by violent contractions of the pectoralis major muscle still less frequently it follows subcutaneous saline infusions into the chest wall. As a result of trauma fat is released from its enclosing membrane and is set free in the interstitial tissues where it is acted upon by enzymes and converted into fatty acid salts. A round-celled and foreign body reaction is called forth and a palpable tumour is formed. Clinically *fat necrosis* of the breast presents itself in two ways.

Acute Form.—This is well illustrated by a young woman of 25 years of the leisured classes who suddenly started to dig furiously for victory in heavy soil. After an eight hour day she was awakened in the early hours of the following morning by a severe pain in the left breast Within twenty four hours so severe were the pain and tenderness that a breast abscess was diagnosed When first seen the swelling in the upper quadrant was so tender that no adequate examination was possible but no other sign of inflammation was present

Local heat and intensive short wave therapy led to complete resolution within ten days

Chronic Form is much more common than the acute A hard mass is formed by the fibrous tissue reaction so that it is frequently mistaken

from the nipple without pain or thickening in the breast The discharge may be blood stained at times in some cases it will cease altogether after which a small tumour can be felt in the affected lobe owing to cyst formation occurring in the obstructed duct On examination it will be seen that the discharge always comes from the same orifice and pressure over one localised area will produce it. Papillomata show a tendency to become malignant and for this reason, and because they may be multiple no local removal should be considered The breast disc is removed with the nipple and areola

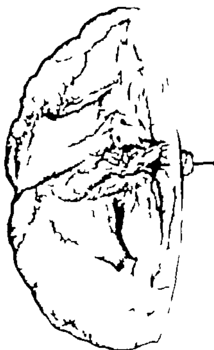


Fig. 243
Duct papilloma of the breast.

Pure Adenoma

This is a rare tumour seen in girls and young women forming a soft smooth rounded swelling in the breast It is encapsuled and consists of normal looking breast tissue except that the tubules have no lobular arrangement and there are no ducts It may grow to a large size and is better removed

The benign connective tissue tumours are all described as occurring in the breast but are more or less pathological curiosities A fibroma may occur within the breast or as a pedunculated tumour from beneath the skin of the areola A lipoma may be found in the breast either as a localised or diffuse type

Fibro-adenomata

These are the commonest benign tumours in the breast Two varieties are described hard and soft

Hard Fibro-adenoma.—This the common type occurs in women between 20 and 35 years of age the majority being between 20 and 30 years It is an encapsuled and lobulated tumour with a smooth surface having a small vascular pedicle and being separated from surrounding breast tissue by loose areolar tissue Microscopically two types are described pericanalicular and intracanalicular The pericanalicular shows a dense overgrowth of connective tissue around the acini which are compressed and *appear as small tubules with flattened* epithelium lying in a mass of fibrous tissue In the intracanalicular type the fibrous tissue hyperplasia affects the acini which are distorted and drawn out into narrow chink like spaces (Fig 244) Both types are frequently seen in the same microscopic section and neither have any connection with the soft fibro-adenoma.

Clinically it forms a tumour which is painless, and which the patient notices accidentally when washing It is firm but elastic, and has a smooth lobulated surface It is so freely movable that it constantly slips away from the examining finger and this movement is independent of the breast tissue They may be multiple in the one breast or present in both Fibro-adenomata should be removed as they are always a source of anxiety and both sarcoma and carcinoma have been known to arise in them

Soft Fibro-adenoma is a rare growth. It is soft rapidly growing



FIG. 244

Microscopic ppearance of an intracanalicular fibro-adenoma of the breast.

and its cells are of an embryonic type It consists of large acini lined by tall columnar cells lying in a fibrous tissue matrix which is unusually cellular So rapidly do they grow that they may break through the skin by pressure atrophy and fungate on to the surface (Fig 245) It is suggested that this tumour may arise in the intra canalicular fibro-adenoma and it has been given many names e.g the serocystic sarcoma of Brodie It is however unquestionably benign. The diagnosis from cystadenoma, encephaloid carcinoma and sarcoma may be extremely difficult In every case the breast should be removed.

Cystadenoma.—It has become customary in recent years to describe this tumour as belonging to a special group though it is doubtful if this can be upheld histologically It is distinguished by its tendency to form large cysts filled by rapidly growing intracystic papillomata

(Fig 246) Essentially it is fibro-adenomatous in origin Clinically it is a rapidly-growing encapsuled tumour behaving like the soft fibro-adenoma and if left it bursts through the skin, although remaining benign throughout It is seen in women between 35 and 45 years of age advances rapidly to vast size, but remains freely movable and gives rise to no enlarged glands.

Treatment is removal of the breast



Fig. 245

Soft fibro-adenoma of the breast.

CARCINOMA

Etiology —In susceptibility to cancer the breast is second only to the uterus in every twenty-seven cases of cancer in women eight are in the breast. The epithelium of the mammary gland is constantly undergoing changes of activity and involution, and it is possibly these changes which render the breast so susceptible to carcinoma | There is some slender evidence that growth may follow an injury and long continued irritation from an unduly prominent corset bone may be a causative factor The hyperplastic and cystic types of chronic mastitis and duct papillomata are recognised as precancerous conditions It is seen most frequently between the ages of 40 and 60 but after 20 no age is exempt It is as common in married as in unmarried in parous as in nulliparous women. The left breast is more often affected than the right and the commonest situation is the upper and outer quadrant, the other areas in order of frequency being the outer and lower the upper and inner the lower and inner quadrants and the axillary tail. Age has a marked influence on the rapidity and virulence of growth, the younger the patient the more rapid and more deadly its advance whereas in the aged the growth may be locally very slow and spread to the glands may take months or even years.



Fig. 246

A cystadenoma of the breast.

Varieties.—Histologically it is possible to divide carcinoma of the breast into groups They are

A The spheroidal or polygonal-celled carcinoma—scirrhus, atrophic scirrhus, and encephaloid.

B The columnar-celled or duct carcinoma.

As these are also clearly defined clinically they will be described separately

The Spheroidal or Polygonal-celled Carcinoma.—The great majority fall into this group and in it three types are described atrophic scirrhus, scirrhus and encephaloid. The differentiation is based on the amount of fibrous tissue in the growth and a clear understanding of the processes involved is essential. Fibrous tissue is the response of the body to attack its main line of defence With the earliest onset of carcinoma a round-celled infiltration is immediately mobilised around the cancer cells If the virility of these cells is so low that the round cells are given time to consolidate into fibrous tissue then the cancer cells may be completely encapsuled This constitutes an *atrophic scirrhus* When however the cells of the growth have intense activity they divide and spread so rapidly that each newly laid-down zone of round-celled defence is swamped long before it can form fibrous tissue, and this is the *encephaloid* type The middle group is intermediate in every sense in that the activity of the cancer cells is not sufficient to prevent fibrous tissue being laid down, but is enough to prevent their being completely cut off. This is the *scirrhus* group which includes the majority It will be appreciated, therefore, that there is a multitude of tumours varying in the proportionate amounts of growth and fibrous tissue, forming in this way a long series beginning in the encapsuled atrophic scirrhus and passing through many intermediate stages to end in the rapidly fatal encephaloid cancer The division into three groups is convenient but arbitrary and it does not permit of every growth being relegated to one or other group with the expectation that it will behave in an identical manner with every other member of that group



FIG. 247
Section of a breast showing an atrophic scirrhus.

Naked-eye Appearances—The Atrophic Scirrhus is a small spherical nodule of dense ivory white tissue with minute yellow or white areas in the centre The breast in which it occurs is usually also small and atrophic (Fig 247)

The Scirrhus has so typical an appearance that it allows a diagnosis to be made with certainty in early cases in which clinical methods leave it in doubt. On cutting such a growth open the knife is gripped in a curious way the impression being gained that the cut surfaces are attempting to hold the sides of the scalpel, so that a fine vibratory thrill is communicated both to the fingers holding the scalpel and to those supporting the tumour behind. When the section is complete the cut surfaces become concave. The growth is pinkish white and radiating processes are seen passing into the surrounding fat. The centre shows white and yellow areas due to necrosis and when the edge of the knife is scraped across the surface irregular gritty areas can be felt, and a thick, yellowish fluid collects on the blade (Fig 248)

The Encephaloid Carcinoma is a soft grey homogeneous growth said to resemble brain tissue. It has large vessels running over and through it.

Microscopic Detail—The amount of fibrous tissue varies greatly as has already been described. The growth is of the carcinoma simplex type the cells forming a closely packed mass without any attempt at differentiation. The shape of the cells is governed by *pressure* and they take on irregular polygonal forms. Sometimes they show some indication of a regular arrangement, and papillary alveolar and adenocarcinomatous forms are described. The rapidity of the growth can be judged by the amount of fibrous tissue and the number of mitotic figures present (*vide* Fig 42 p 108)

Method of Spread—Carcinoma of the breast spreads by (1) infiltration, (2) permeation (3) embolism and (4) transcœlomic implantation. These are fully described on p 80

Carcinoma of the breast spreads by these methods to

1 Regional lymph glands in the axilla those along the internal mammary vein and above the clavicle
2. Skin and opposite breast
3 Bones especially ribs, sternum, dorsal and lumbar vertebræ and humerus
4 Lungs and mediastinal glands
5 Liver and
6 Any part of pleura and peritoneum by transcœlomic implantation

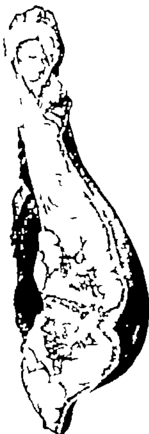


Fig 248

Section of a breast showing retraction of the nipple, the typical appearance of the cross-section of this type of growth and the invasion of the axillary lymph glands.

Scirrhus Carcinoma.—*Clinical Features*—In over 95 per cent. of cases the patient first notices a lump in her breast This discovery is made quite accidentally during washing There has been no pain to call attention to the breast In a few cases sudden and rapid increase in size is the first noticeable symptom while in others it is a small ulcer or a peculiar dimpling of the skin.

The picture of a moderately advanced growth will be described first, and the early signs and late complications discussed later On inspection it is seen that the affected breast is

(*A*) Smaller than the other
(*B*) Raised to a higher level than the other and
(*C*) The nipple is retracted (Fig 248)

These signs are due to contraction of the new fibrous tissue of the growth infiltrating the ligaments of Cooper

(*D*) The tumour may be visible
(*E*) The skin may be dimpled, puckered or retracted.

On palpation of the breast a tumour will be felt which has the following characteristics

1 It is either regularly spherical or flattened from back to front.
2 It is very hard comparable to a stone
3 Its surface is irregular rough and craggy
4 Its edge is indefinable as it fades imperceptibly into normal tissue and it is impossible to say where one starts and the other ends
5 It is fixed to the skin and underlying deep fascia.
6 It is accompanied by enlarged glands in the axilla.



FIG. 249
An infra photograph illustrating the early carcinoma with a tumour without any other signs. It can be seen only as a slightly more brilliantly lighted area above and medial to the nipple.



FIG 250
Carcinoma of the breast showing *peau d'orange*.

Early Signs —The above description has been accepted as the typical textbook description of a carcinoma of the breast It is, however characteristic of a moderately advanced type in which the hope of lasting cure is small. *Carcinoma of the breast can be, and should be, diagnosed when no sign exists except the presence of a lump* when the breast is not yet distorted and displaced when no fixation and no enlargement of glands has occurred (Fig 249) The physical characteristics of the lump viz its hardness its rough craggy surface and its indefinable edge should provide a diagnosis If any doubt exists the tumour should be explored.

Late Signs — *A* The skin may be affected in several ways *Peau d'orange* or pigskin (Fig 250) is produced by blocking of the lymphatics draining the skin by cancer cells or by fibrosis In this way the affected area of skin becomes swollen except where the hair

follicles and sweat glands penetrate it and as a result their orifices become accentuated and the orange-skin dimpling is closely mimicked The skin becomes thickened and leathery "*Cancer en cuirasse*" is the name given to a more advanced condition in which the leathery texture of the skin has become much more marked the colour has turned to purple and crusts have formed on the surface Hard nodules of growth are present on the skin, the cells having reached this level by permeating the cutaneous lymphatics A carcinomatous ulcer may form as a result of direct spread from an underlying growth (Fig 251) or from the ulceration of a secondary nodule (Fig 252) It presents the typical hard, everted and raised edges



FIG. 251

Ulcerating carcinoma of the breast.

B "*Brawny arm*" is due to widespread lymphatic obstruction around the shoulder region preventing any collateral lymph circulation being established. Blockage of the main axillary trunks alone is not sufficient to produce it. The oedema at first pits on pressure but soon becomes hard and brawny The arm swells to twice or thrice its normal size and the skin is tense and shiny Pain becomes continuous and paralysis finally occurs.

Diagnosis—This rests between hard fibro adenoma chronic mastitis and carcinoma. The differentiation is shown in tabular form (p 536)



FIG. 252

Ulcerating secondary nodule in skin after radical mastectomy

Prognosis—In those cases in which lymphatic glands are palpably enlarged the chances of complete cure are not good When in addition, the skin is ulcerated or the chest-wall infiltrated, then a fatal issue is likely In very old women quite a large superficial growth can be present without any metastases and the prognosis is good. But in every case particularly in the early cases it is most unwise to give a prognosis until the pathologist has reported on the material. The amount of fibrous tissue the number of mitotic figures and the presence of cancer cells in the lymphatic glands are by far the most reliable guide

Treatment—1 Definition of operability A case is operable unless the growth has infiltrated the chest-wall, caused cancer *en cuirasse* or produced a fixed mass in the axilla, enlarged fixed supraclavicular glands or definite metastases at a distance

DIFFERENTIAL DIAGNOSIS OF SWELLINGS IN THE BREAST

	Fibro-adenoma.	Cystic Mastitis.	Carcinoma (Early).	Carcinoma (Moderately Advanced).	Soft Fibro-adenoma; Cystadenoma.	Encephaloid Carcinoma; Sarcoma.
Symptoms	Lump noticed by chance.	Pain.	Lump noticed by chance.	Lump.	Lump.	Lump.
Size of Breast	Normal.	Normal or a little enlarged.	Normal.	Shrunken.	Enlarged.	Enlarged.
Position of Breast	Normal.	Normal.	Normal.	Elevated.	Pushed forward.	Pushed forward.
Nipple	Normal.	Normal.	Normal.	Retracted.	Pushed forward.	Pushed forward.
Skin	Normal.	Normal.	Normal.	Puckered, dimpled peau d'orange.	Thinned. Gives way. Fungating mass not attached to skin edge.	Early peau d'orange. Thinned and gives way. Fungating mass attached to skin edge.
Consistency	Solid, firm, elastic.	Solid, elastic.	Stony hard.	Stony hard.	Soft. Cystic in parts.	Soft. Very vascular
Surface	Smooth always. Lobulated often.	Cyst smooth; ropy knotty covering.	Irregular. Craggy	Irregular. Craggy	Smooth. Lobulated.	Smooth. Lobulated
Edges	Clearly defined.	Fairly defined.	Indefinable.	Indefinable.	Well defined.	Fairly defined.
Fixation	Nil.	To breast tissue.	To breast tissue.	To breast tissue, skin, deep fascia.	Nil.	To everything.
Glands	Not enlarged.	Not enlarged; occasionally large, soft, tender	Not enlarged.	Enlarged.	Not enlarged.	Great enlargement in encephaloid. None or moderate in sarcoma.

2 Exploration of the small doubtful tumour The early cases with no signs except the lump in the breast may cause uncertainty In these cases no words can condemn sufficiently strongly the attitude of wait and see Such a policy may result in a curable growth being allowed to become incurable (though not necessarily inoperable) The growth must be explored and permission obtained for the performance of the radical operation if found necessary Under general anæsthesia the tumour is either cut into *in situ* or removed completely and cut open outside the body The naked-eye appearances are pathognomonic If they prove carcinoma, a small swab soaked in pure carbolic acid is placed in the wound and the skin sewn up over it. Towels gloves and instruments are changed and the radical operation is performed.

3 The radical operation The principles governing this operation are based on the study of lymphatic permeation It is described on p 540

4 Palliative removal. In old women a slowly growing carcinoma may reach some size before they seek advice At first sight its size and the evidently imminent ulceration of the skin lead to an opinion that it is inoperable On closer examination no glands can be detected, and the degree of fixation to the pectoral fascia is not advanced. In such cases it is certainly justifiable to advise a local removal of the breast without attempting the radical operation. The danger discomfort and pain of an ulcerating growth are thereby obviated, and it is surprising how good are the results

5 After treatment. In every case prophylactic X ray treatment should be advised. Although it may not be absolutely necessary in the early case nevertheless it should be adopted as the routine procedure

6 The position of radium A great deal of research work has been done in connection with breast cancer The results are not encouraging so far as final prognosis is concerned. Early growths are destroyed as successfully as in the tongue, but the five-year results are not as good as those following radical removal which still remains the treatment of choice

Atrophic Scirrhus.—This type of mammary cancer provides the best example of the human body's attempt to destroy a malignant process and achieve a natural cure The cancer cells are of such low vitality and divide so slowly that an extensive fibrous reaction surrounds them. Patients may live for many years with such a growth and die from intercurrent disease or after several years and for no accountable reason widespread dissemination may occur Such an example is in the St Mary's Hospital museum the primary growth (Fig 247) being a tiny atrophic scirrhus in a shrunken breast which after many years gave metastases in almost every bone in the body These growths may form so small a tumour that the patient remains unaware of their presence until puckering of the skin or ulceration draws attention to them Some remain in this condition, while in others fibrosis spreads throughout the breast which becomes shrunken to such an extent that it resembles the male breast

Sampson Handley advises removal of the breast disc in every case, for as he says no one can foretell when an atrophic scirrhus may blossom forth into active dissemination

Encephaloid Carcinoma.—In these growths the intense activity of the cells allows no time for a defensive fibrosis to be laid down. A very rapidly growing soft homogeneous mass resembling the grey matter of the brain is formed. It consists of a pure polygonal-celled carcinoma simplex with no attempt at alveolar arrangement. It is fortunately a rare condition occurring in younger women before the age of 35 years in whom a rapid enlargement of the breast is noticed. None of the typical signs of scirrhus is present The skin early develops *peau d'orange* and is quickly broken through a fungating mass being formed which differs widely from the ulcerating scirrhus (Fig 253).

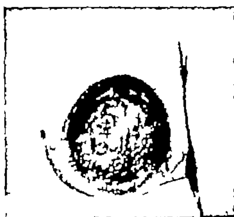


Fig 253

A fungating encephaloid carcinoma.

Glands in the axilla are enlarged to great size, and the growth disseminates early and widely to all parts of the body leading to a fatal issue within a few months It is doubtful if any attempt at operative treatment is justifiable Heavy radiotherapy may check the speed of growth but does not alter the inevitable result

Acute Inflammatory Carcinoma.—This rare type is similar to the encephaloid but it is even more rapidly growing and so great is its vascularity that the breast becomes red hot and throbbing It is *usually but not invariably seen in lactating breasts. It may* be mistaken for a breast abscess so sudden is its onset so rapid its growth and so suggestive are the signs of inflammation These cases are inevitably fatal and no treatment is of any avail.

Peripheral Carcinoma.—Carcinomata of varying degrees of activity particularly at the atrophic scirrhus end of the series, sometimes arise in the terminal parts of the alveoli at the periphery of the breast. As these may lie outside the apparent gross limits of the breast, the condition is not always recognised as mammary It is for this reason that this group is specifically mentioned Growths of the axillary tail are comparatively common, the crease where the skin of the breast is reflected on to the chest-wall may provide examples of these peripheral growths and Handley has recorded cases exactly in the midline of the sternum between the breasts They are all polygonal-celled tumours of the atrophic scirrhus type With regard to prognosis, they are nearer to the main lymphatic fields, and dissemination is apt to occur earlier than in the case of a central mammary cancer of equal growth rate. They usually attract attention as little ulcers or by puckering of the skin, and the underlying tumour may be very small It is imperative

that these points should be understood as such clinical signs may be passed over as of little importance because they are not apparently connected with the breast

Columnar-celled Carcinoma.—This tumour probably arises from the ducts and is therefore termed a duct-carcinoma *It is believed* to arise from the malignant degeneration of a benign duct papilloma Microscopically dilated duct spaces will be seen filled with cellular *debris* and *containing* one or more papillary growths, the surrounding breast tissue being invaded by a columnar-celled cancer Other forms of this growth produce an adenocarcinoma with well formed acini but even in them all the infiltrating cells tend to revert to the simple polygonal form Clinically the duct carcinoma gives a discharge from the nipple which is probably blood-stained and a small nodule may be felt in the breast near the nipple. They are of slow growth and although the skin may be affected early they disseminate late The treatment is the same as for the polygonal-celled growths

SARCOMA OF THE BREAST

Mammary sarcoma is very rare the incidence being well under 1 per cent. of all breast tumours It occurs usually before the *menopause and sometimes in young girls* There is some evidence to suggest that it follows a blow It may be a highly malignant round celled type or a less malignant spindle-celled growth. It is a rapidly growing tumour without pain and without any shrinkage of the breast or retraction of the nipple It grows to a large size filling the whole breast, and finally the skin gives way a fungating mass being formed. The axillary glands are sometimes normal, but occasionally they are enlarged *even before secondary infection is brought* about by invasion of the skin The tumour is very vascular and severe even fatal, hæmorrhages occur after fungation. Generalised dissemination occurs rather later than would be expected in a case of sarcoma. If seen early a radical operation should be performed as for scirrhus carcinoma

Teratoblastoma of the breast is a pathological curiosity and is of no clinical importance

THE MALE BREAST

The male breast is very rarely the seat of pathological processes but it may be the subject of any of the diseases which attack the female

CHRONIC MASTITIS

Reference has already been made to the so-called mastitis of puberty in which the boy is brought for advice because of a swelling in one breast *This attempt* to develop a breast is more common than is generally supposed.

In later life true chronic mastitis may occur in the male and in every respect is similar to that seen in the *female*

Treatment is removal.

CARCINOMA

This is very occasionally met with in the male It may be either a scirrhus carcinoma simplex or a columnar carcinoma. The former is a small hard tumour below the nipple or areola and has all the clinical appearances of the corresponding tumour in the female the latter is somewhat more common growing as it does from the rudimentary ducts attached to the nipple It *presents as a swelling from* the surface and pushes the nipple and areola forward. Ulceration occurs in the later stages. In men these growths become evident in the early stages but the prognosis is usually poor

Treatment consists in radical removal

OPERATIONS ON THE BREAST

Operation for Localised Swellings.—These will include fibro-adenomata, indurated patches of mastitis and cysts of varying types. Two methods of approach are available

1 A radial incision is made over the prominence of the swelling in a line radiating from the nipple to the periphery The dissection is carried down through the fat and breast tissue until the swelling can be isolated and removed. Bleeding points are secured and ligated, deeper tissues brought together with catgut and the skin closed with fine silkworm gut. A small wick of soft rubber tissue drains the wound for twenty four hours.

2 However perfect the above scar may be, it is visible and mars an object of æsthetic beauty Swellings in the lower and outer quadrants may be approached in such a way that no obvious scar can be seen. The breast is elevated and a curved incision made in the skin crease which marks the reflection of the integument from chest to breast. The dissection is carried upwards and inwards between gland and pectoralis major the swelling being approached from behind. The space is drained for twenty four hours by soft rubber tissue and the skin closed with fine silkworm gut.

Local Removal of the Breast Disc.—An elliptical incision is made to include the nipple and areola. Its upper limb extends almost to the insertion of pectoralis major and follows the lower border of this muscle while the lower limb ends at the costal margin at the tip of the 8th costal cartilage. The width of skin at nipple level depends upon the size of the breast enough should be taken to ensure easy co-aptation of the skin flaps without tension and also without leaving redundant skin, which would be unsightly The flaps are undercut and retracted and the breast dissected away from the pectoral fascia until finally the whole gland including its axillary tail is free. The wound is closed with drainage.

Under special circumstances when it is indubitably safe to preserve the nipple and areola, a long curved incision in the lower and outer skin crease enables the surgeon to dissect the breast away from the skin, divide the main lactiferous ducts beneath the nipple and free the gland from the underlying fascia *Although the æsthetic result is better than full excision, this* method is not without its risks since the vitality of the skin may be imperilled by so widespread an undercutting procedure

Radical Mastectomy—The general principles governing this operation are based upon the study of lymphatic permeation. While a small area of skin needs removal, a wide sheet of *deep fascia must be dissected away as this* is the main plane of lymphatic spread. For this reason skin flaps must be

raised to expose the necessary operation area beneath This is bounded by the clavicle above the opposite edge of the sternum medially the anterior border of latissimus dorsi laterally and the first fibrous intersection of the rectus sheath below

The tissues to be removed are —

(a) An area of skin between 4 to 6 in in diameter according to the size of the growth which is at its centre This area must include nipple and areola.
(b) The whole breast.
(c) The sternal part of the pectoralis major muscle
(d) The whole of the pectoralis minor muscle
(e) The fascia over the serrations of origin of serratus magnus and external oblique and the anterior sheath of the rectus abdominis muscle as far as its first intersection.
(f) The whole of the fibro-fatty-lymphatic contents of the axilla

The most commonly practised incision is some variation of that generally known as the Halstead method, which is a long limbed ellipse Clayton Greene's incision, however gives a greatly superior exposure and allows easier co-aptation of the flaps even after wide areas of skin have been removed. It deserves to be better known even in this country His composite incision may be analysed as follows —

A circular cut is made having the tumour in its centre and including the nipple and areola its diameter is between 4 to 6 in. according to the size of the growth. From this radiate four separate incisions (1) upwards on the pectoralis major keeping well up to avoid the axilla and turning over the tip of the shoulder (2) medially over the sternum (3) downwards and inwards over the rectus sheath, and (4) directly backwards well past the anterior border of latissimus dorsi. This is but the general plan, it will be clearly understood that minor adjustments will have to be made for growths in different situations. It is wise that these incisions should be marked out by a scratch made by needle point before the first cut is made.

The first step is to reflect the inner and upper flap to expose pectoralis major Next the axillary flap is turned down, thus exposing the whole axillary region and defining the anterior border of latissimus dorsi. The lower border of pectoralis major having been identified high up near its insertion, the division between its sternal and clavicular heads is carefully displayed and the former divided close to the humerus. The muscle is now lifted clear of the chest wall by finger dissection and the division between the two heads carried back to the edge of the sternum. Pectoralis minor is now identified and its tendon of insertion into the coracoid process divided near to this bone The axillary sheath is thus displayed in its entire length and the vein is to be cleanly dissected. This entails the recognition and division of all downward and forward running branches of the axillary artery and their accompanying veins These are all taken between forceps and divided as close to the vein as safety permits. The one structure to be preserved with great care and dissected free in its course down to the latissimus dorsi is the middle or long subscapular nerve The whole of the fibro-fatty lymphatic contents of the axilla can now be swept downwards and medially This extensive area of dissection is covered with hot saline packs and the remaining incisions completed thus enabling the operator to reflect the lower flaps. The fascia is carefully dissected off the digitations of origin of serratus magnus and external oblique and lastly the anterior rectus sheath as far as its first intersection is removed. The sternal head of pectoralis major and the

CHAPTER XXVI

THE GENERAL SURGERY OF THE ABDOMEN AND PERITONEUM

SURGICAL ANATOMY—The anatomy of the abdominal wall, its muscles, nerve supply and general arrangement are described in Chap XXVII under the heading of hernia The abdominal viscera are described in their respective chapters and the anatomy of the peritoneum is dealt with later in this chapter

ABDOMINAL INJURIES

The most prolific cause of abdominal injury throughout the centuries has been the warring instinct of mankind. Historical museums display portions of the lumbar spine with impaled flint arrow heads some of which, imbedded in the anterior aspect of the vertebral bodies limn with unerring surety the transabdominal course of the missile shot by some hand of the Pleistocene period a dual monument to victor and slain.

Abdominal injuries have swayed and shaken international politics the gunshot wound of the abdomen which killed an Austrian Arch duke at Sarajevo set alight the great European conflagration of 1914 while an assassin s bullet penetrated the stomach and pancreas of a famous President of a powerful transatlantic people

When combatant armies fight at some distance from each other as in modern war injuries of the abdomen are no more frequent than those of other regions where proximity between foemen becomes closer the belly constitutes a target and the tale of abdominal injuries must increase Penetrating wounds are the prerogative of passion accident or blast or the capricious effects of air bombardment engender those injuries to the entrails in which no breach of the belly wall exists yet even in the sphere of accident the abdomen appears to be under the special protection of the wonderful muscular reflex of its encompassing parietes.

From time immemorial the belly has been regarded as a vulnerable area it has been hopefully explored by suicides from the days of the Roman Empire it is traditionally disembowelled in the Orient it has been utilised by murderers sometimes in the guise of religious enthusiasts and the most heinous crimes have often been committed in the name of the Church It seems ironical to speak of " bowels of compassion, when the contents of the belly have been exposed to public view even before death and when St Erasmus intestine was coiled around a windlass by fanatics.

Incendiary bullets sometimes necessitated intestinal resection because of necrosis of the gut-wall produced by scorching As in previous wars, *fragments of bone* from the patient or his companion were driven into the belly and damaged abdominal viscera

NON PENETRATING INJURIES

The abdominal parietes may suffer along with the subjacent organs, and ecchymoses and effusions of blood may be found in any of the anatomical layers superficial to the peritoneum When visceral lesions are present actual rupture of the abdominal muscles is rare whereas the blow that ruptures the powerful abdominal muscles is often too spent to injure the intestinal tract It is convenient to describe non-penetrating injuries as affecting (1) the abdominal wall, (2) the hollow viscera and (3) the solid organs.

Injuries of the Abdominal Wall

These deserve special consideration by reason of the difficulties which beset the diagnosis from concomitant damage to the subjacent abdominal organs. The lesions produced by subcutaneous injury which demand special notice include rupture of the rectus abdominis muscle possibly with damage to the deep epigastric artery and, more serious still, those contusions in which the peritoneum is torn as well as the superjacent musculo-aponeurotic structures and a traumatic hernia is present under the intact skin

Injuries of the Hollow Viscera

The potentialities of a belly blow in respect of damage to the alimentary canal are not negligible, and the various lesions resulting can be classified as contusions and ruptures Statistics show that the small bowel is preponderantly liable to trauma the jejunum being hurt far more frequently than the ileum the duodenum takes third place in vulnerability but the appalling mortality associated with its rupture affords eloquent testimony to the frequency with which the duodenal lesion even to-day is unsuspected in diagnosis and overlooked at operation

Contusion of the Intestinal Wall may be *single or multiple* and, although spontaneous healing may result in mild cases, more serious damage may determine subsequent perforation from the separation of a gangrenous patch the development of mucosal ulcers or the late advent of cicatricial stenosis The first mentioned complications are seen between the fourth and the fifteenth days, and their possible occurrence must be kept in mind

Rupture of the Intestine may be complete or incomplete In the latter one or more of the intestinal coats is torn but the lumen of the gut does not communicate with the peritoneal cavity The inner tunics are more frequently damaged than the outer any subsequent necrosis or rupture of the thin remaining layer will lead to peritonitis. In complete rupture the opening in the bowel wall may be no larger

than a pinhead but on the other hand the gut may be completely divided

The rupture may be caused by a compression or a crushing injury by a bursting or a tearing force In *compression* injuries the lesion is either small and rounded or elongated in which latter case the tear runs transversely round the bowel and may constitute a complete section of the gut The edges of the rupture are contused and crushed but temporary protection against the escape of intestinal contents is frequently afforded by the prolapse and eversion of the mucous membrane and by the contraction of the circular muscle fibres to which Jobert de Lamballe first drew attention The duration of this defensive mechanism varies between nine and thirty-six hours in many patients however the escape of intestinal contents is immediate and this is especially true of the large bowel

The uppermost portion of the jejunum is that most frequently ruptured in these non penetrating injuries the great majority occurring in the first second and third coils where they cross the lumbar vertebræ At the other extremity of the small intestine the two terminal coils of the ileum come into contact with the sacral promontory and the right sacro-iliac synchondrosis and rupture of the ileum, though less frequently encountered than the jejunal tears is found to increase in proportion to the proximity of the coil to the ileocæcal junction.

Rupture by *bursting* is rare Complete transverse severance of the bowel is never seen in this injury the wound usually has its long axis parallel to that of the intestine and is found on the antimesenteric border Rupture by *tearing* is still more rare and is always across the long axis of the gut so that total or subtotal tears are the rule

Symptoms and Signs arranged in order of their frequency are — abdominal pain and tenderness rigidity vomiting rising pulse shock, bruising of the abdominal wall and dulness in one or both flanks The protective mechanism referred to above may be so perfect for the first few hours that there will be in effect no symptoms In many patients there will be a concomitant bruising and tenderness of the abdominal wall. It is these two factors which make the diagnosis of non penetrating injuries of the intestine so difficult in many patients

Diagnosis —Zachary Cope emphasised the extreme importance of excluding injury to the spinal cord chest and kidney and then urged that rupture of the intestine should be suspected (1) when the pain persists for more than six hours after injury especially if accompanied by bilious vomiting a gradually rising pulse persistent local rigidity which tends to spread, and deep local tenderness and (2) when abdominal pain is absent or slight but the pulse rate rises steadily and the patient is restless or listless Grant Massie first drew attention to the great value of radiography in diagnosis in the early hours after injury Free gas in the peritoneum can be seen by this means

Prognosis depends on the time that is allowed to elapse before treatment is undertaken Siegel states that of those patients operated upon in the first four hours the mortality is only 15 per cent those who underwent laparotomy between the fifth and eighth hour had a

death rate of 44 per cent and after the twelfth hour no less than 70 per cent succumbed

Treatment—Perhaps the most cogent reason for laparotomy is *doubt* in the mind of the medical attendant It is far better to look and find nothing than to waste valuable time in speculation until definite evidence of peritonitis the harbinger of early dissolution has appeared. The intestinal injury is sought for and the wound closed simple suture may suffice or resection and anastomosis may be needed in total section of the bowel Care must be taken to ensure that a second lesion does not coexist The treatment of the peritoneum varies with the amount of the soiling if the effused contents are *strictly limited*, dry sponging only should be employed and the belly wall may be closed without drainage if the escaping contents are widely spread, gross infective material should be wiped up the fluid aspirated by suction and drainage employed The local and oral employment of penicillin and sulphadiazine is to be encouraged.

Injuries of Solid Viscera

Non penetrating injuries of the solid viscera present the picture of internal hæmorrhage which has been described fully in Chap VIII

Tears of the Liver are most often the consequence of blows on the right hypochondrium or the lower part of the right side of the thorax they may be produced also by contrecoup in the case of falls from a height The degree of damage varies from a central rupture or subcapsular hæmatoma to severe disruption and even complete separation of a portion of the liver which may be loose in the peritoneal cavity It is affirmed that the right lobe is damaged six times as frequently as the left and that the convexity of the organ is torn twice as often as the concave surface The liver takes first place among the solid abdominal viscera in its liability to injury

Clinical Picture.—In the grave form of injury shock is severe there is tenderness over the liver area, diffuse rigidity of the abdomen and diminished amplitude of respiratory excursion. The signs of cataclysmic internal hæmorrhage will dominate the picture

In less grave cases there may be only slight shock and localised tenderness over the hepatic area the pulse will be slow and signs of mild jaundice develop subsequently There may be the complaint of pain in the subscapular region when the convexity of the liver is torn or in the epigastrium when the tear is in … surface Rectal examination may dem… that the po… is becoming progressively fuller (I…

Prognosis and Tr… …e minor … injury recover spontaneously the … demand … ery It is said that between 60 and … of p… …ly injured to require … op… Grey … arning that the … partly … action of the a… use … as soon … der …arch … m… … once

throughout the operation A midline incision is rapidly made and the bleeding controlled by compression of the structures in the free edge of the gastrohepatic omentum Finally the bleeding is arrested by packing the laceration with gauze impregnated with paraffin and flavine or by means of absorbent gauze (oxidised cellulose) by *lining the rent with* omentum and filling this omental cavity with gauze On the other hand the edges of the laceration may be approximated by means of mattress sutures of thick catgut introduced on a round bodied needle or by a chain of inter locking sutures as shown in Fig 254



Fig. 254

Method of repair of the liver after rupture Not the technique for preventing the coaptation sutures cutting out. (*After Grey Turner*)

Rupture of the extrahepatic bile ducts is uncommon, and symptoms are due to intraperitoneal extravasation of bile The treatment consists in drainage of the extravasated bile possibly drainage of the gall bladder may be superadded Suture or drainage of the duct itself may be possible in the early cases

Rupture of the Spleen.—Damage to the spleen may occur at any age of life even in a new born babe dropped on the floor in pre cipitate labour and is not uncommon in children The organ has been injured by violence of every degree but the spontaneous rupture of a normal spleen has never quite satisfied critical inquiry The proclivity of the abnormal spleen to spontaneous rupture is of course well known and to the enlarged spleen of malaria attaches a special liability to this dramatic complication (Fig 255)



Fig 255

A spleen showing multiple radiating tears.

The *clinical signs* are those of grave intra abdominal hæmorrhage which may be catas trophic in its severity and suddenness and shoulder pain, especially in the left side when the patient lies down or tries to sit up Rigidity is not always present and is more common in children than in adults There are also cases of prolonged slight hæmorrhage in which the bleeding goes on slowly into the peritoneal cavity There is a further group in which a latent period has lasted for more than forty-eight hours and been followed by the abrupt onset of a most severe hæmorrhage

Treatment consists in immediate operation probably the most certain and safe method of arresting hæmorrhage consists in splenectomy

Injuries to the Pancreas are very rare but are also of interest

from the possibility of the subsequent development of a pseudo-pancreatic cyst or a pancreatic fistula

PENETRATING WOUNDS OF THE ABDOMEN

The diagnosis of intestinal injury due to a penetrating wound in the abdomen is not beset with the same difficulty that obtains in deciding whether the bowel has been damaged by contusions or non penetrating violence and the indications for treatment are more clear Whatever the traumatic agency a stab with a *knife dirk or dagger* a sword or bayonet thrust a wound from bullet shell or bomb a laceration by spike stake or animal's horn, the general principles are alike. A penetrating wound of the abdomen probably means a penetrating wound of bowel or solid viscus be that as it may *every case* demands the earliest surgical interference (Fig 256)

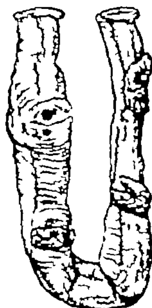


Fig. 256
Multiple gunshot wounds of the small intestine. Note the pouting of the mucous membrane

Symptoms and Signs—An escape of fæcal material or flatus from a wound involving the abdominal parietes or even a part of the body remote from the cœlom is self-evident proof of an intestinal lesion An abundant and persistent discharge of blood from wounds in the back, flank or belly wall an ebb which flows faster and with greater force when the patient coughs or makes an effort, will suggest some deep visceral injury No comment is needed upon those cases where a portion of the abdominal contents projects from a wound, and still more significant will be the diagnosis if the patient is shocked and blanched passes blood from the rectum or has a hæmatemesis

The situation of the wound may not at first suggest an involvement of the peritoneal cavity or its contents The wound of entry may be for example in the thorax buttock or thigh *injuries fraught with the gravest danger*

In addition to obvious evidence the following signs and symptoms assist in the diagnosis Rigidity pain and tenderness vomiting a rising pulse rate and an expression of profound anxiety are all suggestive No one sign or symptom individually is diagnostic but when they are present in combination the clinical picture becomes clear An X ray examination will give valuable information as to the direction of the missile and may furnish *useful suggestions as to the best mode of* approach in a particular case

Radiological evidence of the presence of gas between the liver and diaphragm in penetrating wounds of the abdomen should not be considered as certain evidence of intestinal perforation since air may be taken into the cœlomic cavity by the missile and the bowel escape scatheless

A most helpful diagnostic manœuvre is the auscultation of the abdomen, which depends on the fact that peristalsis ceases if the bowel is severely damaged There are fallacies about this test since the whole of the involuntary muscle of the intestinal tract will not necessarily be paralysed if there is a small wound in one segment of its length In the Italian campaign Rob found that peristalsis was absent



FIG 237
Exteriorisation of hepatic flexure of the colon for gunshot wound.

in nearly 94 per cent of penetrating wounds of a hollow viscus while in 71 cases with no lesion of a hollow viscus peristalsis was present in 70

Wounds of the Small Intestine.—In war these constitute 25 to 30 per cent of all abdominal injuries and the mortality varies with the character of the associated injuries and the method of treatment required for the intestinal injury—suture or resection the mortality in cases demanding resection is double that where suture suffices Where resection is required, end to-end anastomosis is the method of election

Treatment —It may truly be said that "in the abdomen there are no insignificant wounds." *Every wound* must be explored excised

and disinfected. Experience has taught that early operation improves the result immensely but that the treatment of the intestinal lesions should be as conservative as possible Wherever possible the gut should be repaired by suture and intestinal resections reserved for such injuries as must inevitably lead to leakage gangrene of bowel, and peritonitis unless dealt with radically

Wounds of the Large Intestine.—These constituted 25 to 30 per cent of all the abdominal injuries of war and the mortality varied from 10 per cent. in small solitary wounds to 70 per cent in large or multiple wounds associated with other injuries

The methods of treatment available are

(i) Sutures, with or without drainage

(ii) Suture associated with proximal colostomy

(iii) Exteriorisation

(iv) Resection

(i) *Suture alone* should be reserved for minor wounds especially of the right colon and for the experienced operator

(ii) *Suture and colostomy* is used particularly for wounds of the lower pelvic colon and rectum.

(iii) *Exteriorisation* has been the greatest single contributory factor to the improved results in colon injury The damaged bowel is best brought to the surface through a separate stab incision any excision is preferably performed extraperitoneally forty-eight hours later A spur should be formed whenever possible

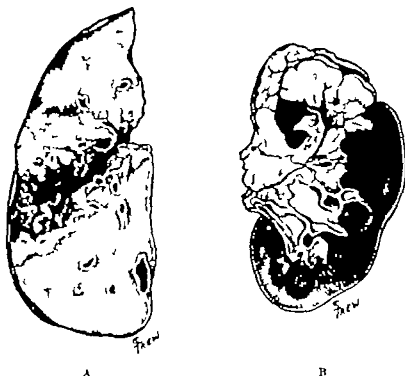
(iv) *Resection*.—Despite its severity resection may be preferable to exteriorisation of wounds of the cæcum too severe to be dealt with by sutures few recover from the horrors of a right-sided anus resulting from an abdominal wound. Drainage and the use of sulphadiazine and penicillin are of value in wounds of the colon.

Penetrating Wounds of the Stomach are not very common (5 to 7 per cent of abdominal injuries) and are usually associated with severe abdominal bleeding which may come from the vessels of the stomach wall or along its curvatures Wounds of the stomach are of infinite variety depending on the size shape and velocity of the missile the direction of its flight the state of the stomach in respect of repletion or emptiness etc Occasionally the wound is small and there is no attempt at eversion of the mucosa but some lacerations are lengthy wide and gaping and the organ has been turned inside out The mortality varies with the associated injuries, from 25 to 50 per cent

Penetrating Wounds of the Liver constitute about 10 per cent of all abdominal injuries The dimensions of the missile play a consider able rôle in determining the type of hepatic lesion, which is almost protean in character varying from a perforation possibly with cracks and fissures radiating therefrom or a superficial score to a ragged wound or a crateriform cavity The liver is damaged in almost every abdomino-thoracic wound on the right side and may be badly shattered in such injuries as the stove in chest The whole organ may be

disrupted even by a bullet wound and large fragments may be found loose in the peritoneal cavity

In many cases of liver injury there are few arresting clinical signs and such patients are often wisely left alone It is significant that out of all the abdominal wounds of the war which recovered without operation the majority lay in the liver area The danger of bleeding depends mainly upon whether large veins have been broached for if



A B

Fig. 238

A. Through-and-through missile wound of the liver showing the ragged track.

B. Gunshot wound of the kidney; bullet had passed through the upper pole of the kidney cutting off its blood supply so that it presented the appearance of an old white infarct

these have escaped hæmorrhage ceases spontaneously There is usually little oozing of bile unless main ducts are severed. Early jaundice has no serious portent but late icterus has a grave significance and indicates serious infection

The methods of dealing with penetrating lesions of the liver are akin to those detailed under non penetrating injuries. The use of a sulphadiazine suspension in gelatine and saline is worthy of consideration —an adequate concentration is assured at the site of possible infection during the first forty-eight hours The statistics of the B.L.A. cases of liver laceration from penetrating injury coming to operation showed

a mortality of 50 per cent from suture 60 per cent. from packing and 20 per cent from drainage only—doubtless the slightest or late cases. The use of oxidised cellulose proves of considerable value

Penetrating Wounds of the Spleen.—In considerably more than half the cases of splenic injury *there will be no damage to the other* abdominal viscera The symptoms are those of internal hæmorrhage, the amount of which mainly depends upon whether the splenic vessels are injured The pulp is said to cease bleeding within ten hours, but this time may be prolonged to forty-eight hours.

Treatment—Although Sir Cuthbert Wallace in 1918 had advised that the spleen should not be excised unless it were badly disrupted, or the main vessels torn the surgeons in the 1939-45 war demonstrated a marked proclivity to perform splenectomy and in the case of thoraco-abdominal wounds showed a preference for the trans-diaphragmatic approach, which was in fact associated with a lower mortality than the abdominal route Where a conservative attitude towards the injured spleen is adopted it must be remembered that interference with the blood-clot may restart bleeding and necessitate ablation

Rupture of the urinary bladder the kidney and the pancreas will be found described in the chapters dealing with these structures

Recent Advances.—The last world conflict added to our knowledge of abdominal injury In the total warfare of to-day when most of the injuries on the home front are the result of collapse of buildings or the impact of baulks of timber masses of stone or fragments hurled with explosive force against old and young, woman and babe warrior and cripple operations for injuries of the belly due to enemy action were remarkably infrequent The tale of abdominal operations amongst casualties in ships is also a small one It might have been thought that many of those killed in air bombardments of cities perished from abdominal lesions such a surmise found no confirmation on post mortem investigation of fatal casualties The recovery rate of abdominal casualties on the home front and in the field" steadily improved through the years of the last World War until a recovery rate of over 70 per cent was attained despite the fact that the cases were not selected for surgical interference after painstaking scrutiny Operators have indeed vied with each other in their efforts to bring the resources of surgery within the reach of every wounded abdominal case who was not already obviously beyond all mortal aid. This great attainment despite the fact that many abdominal injuries were complicated by other lesions, *even a fracture of the femur* a broken pelvis, or a wound of head or chest affords heartening proof that British surgery has not stood still since 1918

Blast.—The effects of *blast* attracted little attention in the first Great War although Sir Leonard Hill affirmed that the air in the pulmonary alveoli *might be compressed by blast acting upon the* abdomen Clinical and operative experience lends no support to the view that primary blast effects upon the abdomen do not constitute a preponderant cause of fatality in the field or in air attacks on cities, and this is confirmed by post mortem findings in fatal casualties I

have elsewhere recorded fatal cases due to this mechanism under the care of Mr D H Patey, Mr Blacow Yates and others minor degrees of "blast abdomen" may be recovered from (O'Reilly) In experimental work, Zuckerman found that the abdomen was indubitably less vulnerable than the thorax of the hollow viscera the colon was more liable to show changes than the small gut Both in

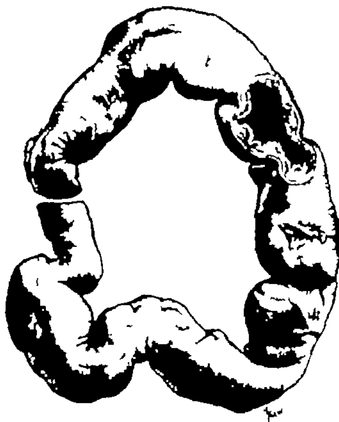


FIG. 250

Blast injury of the small intestine showing the infiltration of the bowel tunics with blood, etc.

experimental work and in human pathology perhaps the most characteristic blast effects are retroperitoneal hæmatomata hæmorrhages between the leaves of the mesentery and subserous and submucous hæmorrhages of varying extent in the bowel wall (Fig 250) The spleen may be torn in persons exposed to blast the liver has been bruised or torn or its right lateral surface may be diversified by lines corresponding to the ribs

For an account of the physics of blast in water (immersion blast), reference must be made to the work of Surgeon-Commander Rex Williams R.N and to the writings of Sir Cecil Wakeley and his colleagues Their work also showed the vulnerability of the lungs as compared with the abdomen, thereby confirming the work of

Zuckerman Protection of the abdomen in animals subjected to experimental immersion blast rendered the pulmonary lesions less severe than in those animals that were either unprotected or had received chest protection It seems clear therefore that while pulmonary blast injuries may be due to the direct impact of the pressure wave on the thorax the upthrust to the diaphragm through the abdomen may be equally perhaps more dangerous.

The colon appears to be implicated with a frequency at least equal to and possibly greater than the small intestine The air-containing abdominal viscera are almost exclusively those damaged by immersion blast although a case of hæmoperitoneum from a torn liver has been recorded Gill and Hay stress the proclivity of the intestine situated in the lower part of the abdomen to suffer damage but the cæcum is indubitably the part most frequently involved

The lesions in the gut wall vary from submucous and subserous hæmorrhages, tearing of the bowel tunics to complete rupture of the intestine which may be a single laceration or multiple in character

In cases not associated with primary perforation the outer bowel coats may be torn, leaving only the mucosa on the other hand intra mural hæmatomata perhaps associated with damage to the blood vessels in mesentery or mesocolon may jeopardise the blood supply and produce a localised necrosis of the bowel, leading to *secondary perforation* a serious and grave menace to survival The bowel lesions are generally associated with retroperitoneal hæmorrhages and with mesenteric and other subserous hæmatomata

All degrees of severity are encountered clinically from those where shock is so great that death rapidly follows to the mildest type associated with abdominal pain and tenderness Those most gravely injured are rarely rescued from the water and have doubtless sustained rupture of abdominal viscera and severe internal hæmorrhage probably there are concomitant injuries to the lungs and even to the brain

The operative recovery from the condition is only about 50 per cent. Secondary perforation which may occur even ten days after the incident is calamitous indeed.

SURGICAL AFFECTIONS OF THE ABDOMINAL WALL

Inflammatory Diseases.—Tuberculous abscess may be met with in connection with tuberculosis of the lower ribs or costal cartilages or even of the os innominatum A primary chancre has been seen on the abdominal wall above the pubis but until the advent of the recent war had been a very rare lesion gummata are likewise rare Actinomycosis is encountered characteristically in the right iliac fossa and is marked by a board like infiltration of the abdominal wall and the presence of sinuses and fistulæ

Hæmatoma of the Abdominal Wall is almost always due to the rupture of the rectus abdominis muscle or of one of the larger vessels

intimately associated with its blood supply The tear may be partial or complete and most frequently involves the infra umbilical portion of the muscle (Fig 260) The cause is rarely a direct injury but more often due to some sudden muscular action such as coughing The onset however may be quite insidious and in such cases the condition may be a complication of an acute infective or debilitating disease thus adding to the anxieties of a case e g of typhoid fever or influenza The fecund woman appears more prone to this catastrophe than is her barren sister the condition is usually met with in the elderly

The rectus muscle may also be ruptured during the spasms of tetanus or strychnine poisoning but such are only pathological curiosities

Treatment consists in suture of the torn muscle and its sheath.

New Growths of the Abdominal Wall.—The skin of the abdominal wall is naturally liable to the same lesions that may be found elsewhere A squamous-celled carcinoma of the anterior abdominal wall is common in Kashmir (the well known *kangri cancer*) and a similar condition is met with in tar workers and those who have been exposed to X rays A rodent ulcer is only rarely encountered as is a fibrosarcoma (Fig 261)



FIG 260
A rupture of left rectus abdominis muscle below umbilicus.

The Desmoid Tumour (recurrent fibroid of Paget cellular fibroma) is an uncommon tumour of the sheath of the rectus abdominis muscle affecting women more often than men The neoplasm is almost always single occurs below the level of the umbilicus in 75 per cent of cases and never takes origin exactly in the middle line It arises in the musculo-aponeurotic structure of the abdominal wall and when small is completely embedded in the muscle substance more often it implicates the fascial envelopes especially the posterior layer of the rectus sheath Growth is slow at any rate in the early stages, tending to take place along the plane of least resistance that is in the direction of the muscle fibres At first therefore the tumour is oval and flattened and later becomes bossed or lobulated (Fig 262)

These growths are fairly cellular fibromata and there is complete absence of a capsule The peculiar histological features are the inclusion of striped muscle fibres and the sequence of regressive changes which these undergo resulting in the formation of plasmodial masses resembling foreign body giant cells Myxomatous changes may lead to a rapid increase in size but these tumours never become malignant yet are very liable to recur

Clinically the growth is painless the skin moves freely over

it and if the muscles of the belly wall are relaxed the tumour can be manipulated so as to demonstrate its independence of the intra abdominal contents. If the patient is requested to contract the muscles of his anterior abdominal wall the tumour becomes completely immobilised (Bouchacourt's sign)

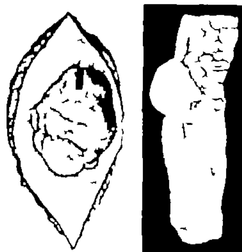


FIG. 261
A fibrosarcoma of the abdominal wall; both surface appearance and cross-section are shown.

Treatment—Early and the most ruthless extirpation is the only effective form of treatment

Osteogenesis in Laparotomy Scars is by no means infrequent The scars especially liable to this change are situated in the middle line involving the linea alba and more commonly above than below the umbilicus Patients complain of slight pain in the wound together with some stiffness or thickening of it

Dilated Veins of the Abdominal Wall serve as a point of some diagnostic importance and the reversal of the normal blood flow has even greater significance The venous blood normally courses from above downwards in the lower two-thirds of the abdominal wall when clinical examination demonstrates that the flow of blood is from below upwards obstruction to the inferior vena cava is almost certain the blood endeavours to reach the heart along the dilated superficial venous collaterals to the superior vena cava



FIG 262
A dermoid tumour.

In cases of compression of the inferior cava by ascites ovarian cysts and other abdominal swellings the veins of the abdominal wall become prominent only at a late stage the coexistence of ascites and the early development of dilated superficial veins is an indication of malignant disease In patients in whom there is no great abdominal distension and no suggestion of an ascending thrombosis from the veins of the lower extremities, but in whom there is early varicosity of the veins of the abdominal wall, it may be presumed that the inferior vena cava is being obstructed by some malignant change in an adjacent structure

SURGICAL AFFECTIONS OF THE UMBILICUS

Discoloration of the skin around the umbilicus (Cullen's sign) occurs in certain diseases *e.g.* ruptured ectopic gestation acute pancreatitis

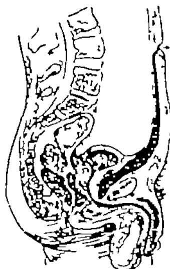


FIG. 263
A drawing illustrating the tracking of pus from the pelvis upward in front of the peritoneum to point at the umbilicus



FIG. 264
An abscess from the posterior abdominal wall tracking forward to point at the umbilicus.

etc *The caput medusæ* is a varicose condition of the veins around the umbilicus but is a most infrequent phenomenon its presence constitutes an arresting advertisement of those habits which have determined cirrhosis of the liver *Acanthosis nigricans* may be seen at the umbilicus as well as in the axilla mouth, neck, around the external genitalia and under the breasts. It usually indicates an associated intra-abdominal malignancy as a rule gastric or uterine carcinoma *Extraperitoneal and Retroperitoneal abscesses* may point at the umbilicus (Figs 263 and 264)

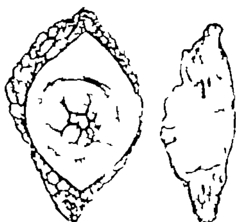


FIG 265
An endometrioma of the umbilicus.

Congenital Malformations include a congenital umbilical hernia i.e., exomphalos (p 640) and certain malformations of the omphalo-mesenteric duct and the urachus which may give rise to a sinus a fistula or a solid tumour The last is

sometimes seen as a bright red cherry like structure filling up the umbilical depression and this has been given the name of an umbilical polyp or the mucous adenoma of the umbilicus

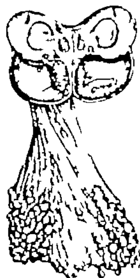


Fig 266
A dermoid cyst of the great omentum.

Secondary Carcinoma of the Umbilicus may develop as an infrequent and late manifestation in connection with diverse primary forms of intra-abdominal new growth being most frequently secondary to carcinoma of the stomach gall bladder intestine ovary and uterus It has also been described in association with carcinoma of the breast

Endometrioma of the Umbilicus is rare and only seen in women during the fourth and fifth decades of life sometimes pain is experienced in the tumour at the menstrual period, and a brownish blood-stained discharge occurs from the navel on such occasions (Fig 265)

DISEASES OF THE OMENTUM

Torsion of the Omentum usually complicates in some manner a pre-existent hernia but apart from this is a very rare condition The patient, who is generally somewhat obese is seized with generalised pain in the upper abdomen This pain at first not very severe becomes more marked and is felt in the right side of the abdomen from the costal arch to the iliac fossa vomiting may or may not occur The diagnosis of a mild appendicitis readily suggests itself but as a rule surgical aid is not generally summoned until about the fourth day by which time a doughy mass may sometimes be felt (Fig 266)

Treatment consists in excision of the twisted portion of the omentum

Growths of the Omentum.—Primary growths of the omentum are very rare A sarcoma has been encountered originating in connection with the inner lining of the lesser sac of the peritoneum a malignant hæmangioma is also described Secondary growths of the omentum are of course extremely common, and may be associated with primary tumours in any part of the abdomen.

Cysts of the Omentum are very infrequent and may be classified as (*a*) lymphatic (*b*) enterogenous (*c*) urogenital, (*d*) dermoid (Fig 266) and (*e*) hydatid.

SURGICAL AFFECTIONS OF THE MESENTERY

Mesenteric Vascular Occlusion (Fig 267) may be either arterial venous or combined the arterial is of two types but embolism is far more frequently encountered than thrombosis which is usually secondary to embolism. The superior mesenteric territory is more often involved than is the inferior mesenteric The venous thrombosis is almost always of a secondary character and may be due to portal

obstruction or to peripheral splanchnic sepsis Fatal pyæmia has on occasion been averted in the latter case by courageous ligature of the superior mesenteric vein, as reported by Julian Taylor

Clinical Picture —Whatever the nature of the vascular occlusion the symptoms are identical and conform to one of two clinical types the first is characterised by a rather more lengthy history and there may have been several attacks of minor severity before the onset of the catastrophe whereas the second variety consists of but one single acute attack.

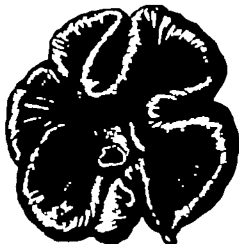


FIG. 267

Coils of small intestine illustrating the appearances seen in mesenteric vascular occlusion.

A. The so-called chronic type exhibits mild symptoms of mesenteric arteriosclerosis for a variable period before the ultimate fulminating infarction There is a history of paroxysms of colic possibly accompanied by the passage of sanious stools while in the intervals between there may be constipation This prodromal period may last for months or even years before the final arterial occlusion occurs

B Acute fulminating mesenteric occlusion. The onset is most dramatic, the anguish intolerable the shock profound and the vomiting severe The pain is experienced all over the abdomen, at first intermittent rather than continuous but later during its greatest intensity the patient draws up the knees and raising the hands in supplication calls out in his agony Hæmatemesis is stated to occur in 25 to 30 per cent. of cases but the writer has not encountered this phenomenon

Complete intestinal obstruction of the paralytic type is not present until gangrene of the bowel supervenes and several evacuations usually take place Bloody diarrhœa occurs in the early stages the blood being either bright red or dark and tarry

Before the onset of peritonitis there is no rigidity but the abdomen is universally tender and there is rebound tenderness. Distension appears early is usually general and on occasion may be extreme The temperature is subnormal, the pulse-rate is rapid from the start and steadily increases The vomiting is profuse and in the later stages typical of paralytic obstruction, the vomitus flowing out of the angle of the mouth in great quantity without the slightest apparent effort on the part of the patient

Treatment consists in resection of the affected coils provided too great a length is not infarcted The use of heparin or dicoumarol is well worth trial as a primary or additional measure

The Mesenteric Lymph Glands.—*Tabes Mesenterica* tuberculous

infection of the mesenteric lymph glands is more frequently met with in children than in adults and the infection indubitably takes place from the imbibition of tuberculous milk the organism being often of bovine type Throughout Great Britain and especially in London there has been a marked reduction in the incidence of tuberculous mesenteric glands during the past twenty five years

The tubercle bacillus can apparently make its way through an intact intestinal mucosa, and the bowel itself may not exhibit any lesion If ulceration of the small intestine is present the appropriate glands will, of course be implicated as well.



FIG. 266
A lymphosarcoma of the Mesentery of the small intestine.

In the early stage of hyperplasia, tuberculous mesenteric lymphadenitis may be associated with attacks of pain, pyrexia, constipation or diarrhoea there may be loss of weight and of appetite and appendicitis may be simulated. The pathological changes which characterise glandular tuberculosis generally may occur in the mesentery caseation and abscess formation may develop peritoneal adhesions may impede the normal functioning of the bowel and may even engender an attack of acute intestinal obstruction The mesentery plays a most frequent and important rôle in the pathology of obstruction, the *fons et origo* of which is often tuberculosis of its contained lymph glands

Tuberculosis of the mesenteric glands rarely coexists with any other tuberculous manifestation, and Gauvain could recall no case of abdominal gland infection among thousands of patients suffering from bone and joint tuberculosis

Treatment—Surgery is reserved for the complications only and dissection of the enlarged glands is to be deprecated. General constitutional treatment should be advised.

Tumours of the Mesentery include lymphosarcoma (Fig 268) fibrosarcoma and myxofibroma or cystic sarcoma all are rare

Cysts of the Mesentery have been classified by Russell Howard and Perry as (1) chylous or serous cysts (2) blood cysts (3) hydatid cysts and (4) teratomatous cysts. They also are rare and their treatment is excision.

Retroperitoneal Tumours are of more interest to the pathologist than to the surgeon the majority are malignant and almost every type of sarcoma has been described.

Retroperitoneal Cysts are classified by Handfield-Jones as follows (1) cysts of urogenital origin (2) cysts of mesocolic origin (3) those arising in cell inclusions (4) lymphatic cysts (5) blood cysts (6) parasitic cysts and (7) those of developmental origin in fully formed organs

Cysts of urogenital origin are thin walled unilocular and have no visible blood vessels in their walls The exact diagnosis is made only at operation or after removal and microscopic examination

GORDON GORDON TAYLOR.

THE PERITONEUM

Surgical Anatomy—The student is referred to textbooks of anatomy for a full description of the intricate details of the general arrangement and relations of the peritoneum and only those essentials which have a direct bearing on surgical problems will be discussed here. The peritoneum is a serous membrane which lines the abdominal cavity providing smooth surfaces to ensure free and unrestrained movement between the viscera further it is endowed with the most marvellous capacity for controlling and overcoming infection, and upon its health and integrity depends the well being of its owner

It covers some parts of the intestinal tract completely thereby forming a pedicle which allows a wide range of movement the mesentery supports the small intestine, the mesocolon (transverse or sigmoid) the free parts of the large intestine, while the stomach is slung in the folds of the gastro-hepatic omentum. Certain solid viscera viz., the liver and spleen, are almost entirely covered with peri toneum, others only partly so The greater part of the duodenum the ascending and descending colon, are clothed only on their anterior surfaces as are the kidneys and the pancreas. These organs are described as being "*retroperitoneal.*" The peritoneal cavity is something of a misnomer since the cavity is but a potential one under normal conditions.

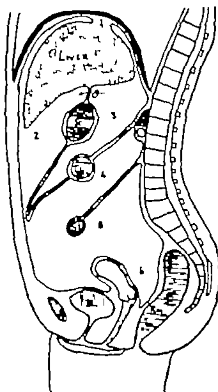


FIG 209

Diagram illustrating some of the peritoneal compartments.

1, is the bare area of the liver; 2, the anterior subhepatic compartment; 3, the lesser sac, the arrow indicating the foramen of Winslow; 4 the space between the transverse mesocolon and mesentery; 5, the space below the mesentery continuous with 6, pouch of Douglas.

Two main divisions of this cavity are described, the *greater* and *lesser sacs* The latter lies behind the liver gastrohepatic omentum and stomach and communicates with the former by a small opening in the suprapyloric region named the "foramen of Winslow The greater sac can be sub-divided (arbitrarily not actually) into two main compartments, one lying above the transverse mesocolon and colon and the other below Fig 209 makes this clear as also that subdivisions of the subcolic area are permissible for purely clinical purposes, between the mesocolon and the mesentery and again below the mesentery down to and including the pelvis. When an

individual is lying supine and horizontal, the promontory of the sacrum and the 5th lumbar vertebra project forward so far that a "watershed" is formed and in this position fluid will flow either upwards toward the liver or downward to the pelvis, according to its relation to this watershed. Fig 270 shows the influence of position on this flow of fluid and illustrates the advantages of "Fowler's position, in which all fluids from any part of the peritoneum tend to flow towards the pelvis, the least dangerous position for the collection of inflammatory exudates.

Above the shelf formed by the transverse mesocolon, colon and great omentum, the peritoneal relations are of considerable complexity and several subhepatic and subphrenic spaces are described. These have special reference to subphrenic abscesses and are set out in full in the section relating to them (p. 572)

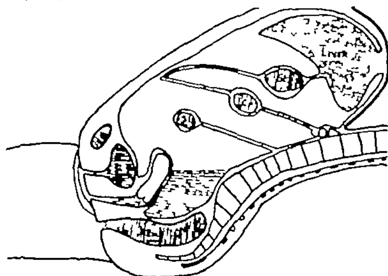


FIG. 270

Diagram illustrating the value of Fowler position showing a collection of fluid in the pouch of Douglas.

The Great Omentum is a special fold of peritoneum derived from the two layers which clothe the stomach These pass downwards from the greater curvature and then turn back to unite with the layers in which is fixed the transverse colon In this way a four layered apron of peritoneum hangs down in front of the small intestine and colon. In its lower part all the layers are fused together and a thin, highly vascular membrane is formed. The great omentum is endowed with wonderful powers of defence and has been described—most aptly—as the scavenger of the abdomen." It seems to be drawn irresistibly to any trouble in the peritoneal cavity and, having reached the scene of action, wraps itself round an inflamed area and envelops it with protective adhesions.

PERITONITIS

Inflammation of the peritoneum or peritonitis may be acute or chronic local or generalised It is almost invariably due to bacterial invasion, which reaches the peritoneum either from the gastro-intestinal

canal the urinary system or the female genital organs and only rarely by penetrating wounds (except in time of war) or via the blood or lymph streams.

Acute localised peritonitis is the inevitable concomitant of most infective intra abdominal diseases but the prompt removal of its cause leads to rapid resolution of the infection The peritoneum possesses the most marvellous powers of defence and recuperation provided it is relieved of continued irritation and reinfection Acute diffuse or generalised peritonitis has a high mortality even when recognised and treated in its early stages and if neglected must certainly be fatal The importance therefore of early diagnosis and prompt treatment of acute abdominal emergencies cannot be overestimated The marked decrease in the incidence of peritonitis is an indication of a greatly improved standard of diagnosis.

Chronic peritonitis is usually tuberculous, though it may result from organisms whose manifestations are more commonly acute viz., gonococcus pneumococcus etc Chronic local or plastic peritonitis produces adhesions and may be regarded as a protective phenomenon.

ACUTE PERITONITIS

Etiology—Acute inflammation of the peritoneum is almost invariably due to invasion of bacteria, the causes of which can be conveniently grouped as follows —

1 Acute infections *e.g* appendicitis diverticulitis cholecystitis salpingitis

2 Acute perforations, *e.g* of peptic stercoral and typhoid ulcers.

3 Injuries of any hollow viscus—penetrating wounds rupture without external wound (*e.g* jejunum)

4 Injury of any solid viscus *e.g.*, liver spleen ectopic gestation in which the intraperitoneal hæmatoma may become secondarily infected.

5 Ascending infections of the female genital tract *e.g* gonococcal, pneumococcal and streptococcal infections (particularly puerperal sepsis)

6 Torsion strangulation and gangrene of solid and hollow viscera *e.g* strangulated hernia, torsion of ovarian cyst, etc

7 Blood-stream infections *e.g* pneumococcal peritonitis during pneumonia

8 Irritation by sterile fluids such as bile pancreatic juice and urine.

Bacteriology—The bacteria which usually inhabit the intestinal canal must play a predominant part in peritonitis Under normal conditions they are almost non pathogenic but in the presence of inflammation, perforation or strangulation of part of the intestinal tract they take on a greatly increased virulence This infection is almost invariably a mixed one and the following organisms may be found (1) aerobes, *B coli B pyocyaneus B proteus* and the pyogenic cocci and (2) anaerobes such as *B welchii*

Pathology—The pathological changes vary considerably according to the severity of the infection and reaction of the patient The onset may be abrupt in origin as in the perforations of peptic or stercoral

ulcers or gradual in the case of inflammatory lesions such as appendicitis in this latter and similar conditions a localised peritonitis occurs gradually on the surface of the inflamed viscus

The peritoneum becomes hyperæmic and inflamed, losing its shiny lustrous appearance and gaining a rough granular surface A fluid exudate is poured out at first clear and serous it later becomes seropurulent and then finally purulent It contains fibrin, which is often deposited in large flakes and which assists in localising the infected area by causing coils of intestine the great omentum and possibly the abdominal wall to become stuck together in this way forming a protective barrier beyond which the peritoneal cavity is normal. This defence mechanism is constantly demonstrated in acute appendicitis the inflamed and possibly gangrenous appendix lies in an abscess cavity the walls of which are formed by the terminal ileum cæcum great omentum and possibly the deep surface of Poupart s ligament

The subsequent course of such an acute localised peritonitis depends upon the efficacy of prompt treatment the virulence of the infecting organism and the powers of resistance of the patient Thus, if the inflamed viscus (e.g the appendix) is removed within the first thirty-six hours the inflammatory reaction will subside, the fibrin will be absorbed and the peritoneum returns to normal with few if any adhesions resolution may be said to have occurred. Under less favourable conditions suppuration may take place within the area shut off by fibrinous adhesions and a localised intraperitoneal abscess forms Finally if a very virulent infection should attack a seriously ill patient in whom the defence mechanism has broken down, pus spreads rapidly among the coils of intestine and a generalised spreading peritonitis is established.

Effect upon the Intestine.—Normal peristaltic action in the intestinal tract must necessarily tend to delay or even prevent the formation of soft adhesions which localise the lesion further it must encourage the spread of the infection by massaging the infected exudate further afield. Nature combats these handicaps by placing the affected segments of bowel at rest by suppressing peristaltic action. Helpful as this is yet it has certain grave disadvantages in that the bowel distends and its contents become stagnant in this way the virulence of the intestinal flora is greatly increased and their passage through the gut-wall into the peritoneal exudate encouraged. In the neglected or more severe cases of general peritonitis this cessation of bowel movement becomes an established paralytic ileus (p. 670) and the patient s life is gravely endangered.

Toxic Absorption.—The immense mortality rate of untreated acute peritonitis cannot be solely due to local conditions. An attempt has been made to explain it by the absorption of *B welchii* toxin from the intestine and the peritoneal exudate (Maybury and Williams) but although this bacillus is often present in large numbers this theory does not gain acceptance to-day and the administration of the anti toxin of *B welchii* is no longer considered helpful. It is probable that the toxæmia is in the nature of an absorption of proteoses and amino-acids from the paralysed coils of intestine

Acute Localised Peritonitis

Acute peritonitis starts as a localised lesion in all abdominal emergencies, except those in which widespread flooding of the cavity occurs as for example in perforations of peptic and stercoral ulcers or in multiple penetrating wounds of the intestine Apart from these conditions generalised peritonitis follows mistakes in diagnosis delayed, ill judged or otherwise ineffective treatment or a diminished resistance on the part of the patient. It is useful, therefore to consider first the clinical picture of localised peritonitis before passing to a description of the more dangerous spreading or generalised disease

Symptoms —These are indistinguishable from those of the causative condition and it is misleading to describe any specific symptoms for local peritonitis. If acute appendicitis is taken as an example the characteristic origin and development of the pain, the initial vomiting or nausea and the constipation are present without the peritoneal coat having been involved but whereas the symptoms alter little when localised peritonitis sets in, the signs change in a definite manner

Signs —The rise in temperature and pulse rate together with the abdominal tenderness, which result from the causative lesion tend to increase with the onset of peritonitis and a new and very important sign makes its appearance viz. *rigidity* Although voluntary guarding of the abdominal muscles may be present in the early stages of many intraperitoneal inflammations true rigidity never occurs until the peritoneal coat is involved. At first localised areas of muscle become rigid and immobile while in spreading infections the whole abdominal wall may become board like in its fixity The differentiation between true and false rigidity is one of the most important clinical lessons the student must master

Two tenderness tests are of value in doubtful cases both of which Zachary Cope has emphasised first the production of pain in the affected region by deep pressure over an unaffected zone, thus being seen in acute appendicitis when pressure over the left iliac fossa produces pain in the right side secondly tenderness on rebound, which is the production of pain not so much by pressure but by the release of that pressure

Auscultation may be useful revealing normal sounds over the unaffected parts and diminished or absent peristaltic sounds in the zone of peritonitis Palpation probably reveals nothing since the rigidity prevents deep examination but at any time a definite tumour mass may be felt. In patients suffering from acute appendicitis a circumscribed swelling is usually to be palpated after sixty to seventy two hours

Diagnosis is that of the causative disease

Prognosis —Prompt diagnosis and treatment should lead to resolution and recovery in all patients Delay will often mean the formation of a local intraperitoneal abscess and, if the patient is unable to localise the infection an acute general peritonitis will follow

Treatment —In the early stages the cause of the peritonitis must be removed promptly and efficiently and in cases of acute localised

peritonitis we do not allow any exception from this rule Any delay may condemn the patient—quite unjustifiably—to the danger of general peritonitis Gonococcal infections in the pelvis are not included for we regard them as a diffuse pelvic peritonitis (see below)

ACUTE DIFFUSE OR GENERALISED PERITONITIS

The origin, etiology and pathology have been discussed above, but it is instructive to consider certain variations in the general picture The onset is variable being dramatically sudden in perforations of the hollow viscera and in acute pancreatitis, and gradually progressive in appendicitis, cholecystitis and infections of the pelvic organs. The course likewise differs widespread flooding of the cavity and very virulent infections leading quickly to a fatal issue The more gradual lesions may persist for several weeks before resolution or death occurs.

Symptoms—*A* Early—This stage will be introduced by the symptoms of the causative disease which merge into those of peritonitis Pain may be of sudden or gradual onset and at first may be localised, but slowly spreads till the whole abdomen is affected. It is of a dull constant aching character which increases in severity as the infection advances Vomiting occurs at the beginning of the attack and becomes a prominent feature of the later stages.

B Late.—Pain increases in severity vomiting becomes profuse and constipation is absolute Even when death approaches, the mind remains clear

Signs—*A* Early—The tongue is furred, breathing shallow and temperature and pulse rate raised. The abdomen is flat or retracted and does not move with respiration. It is tender and very rigid. Auscultation reveals marked diminution or absence of peristaltic sounds.

B Late.—The patient lies half propped up in bed with the hips and knees flexed to relax tension on the abdominal muscles. The face has the earthy pallor of toxæmia it seems to sink inwards to a remarkable degree there is a cold clammy sweat on the forehead and nose and the eyes are withdrawn into the orbits The expression is one of great anxiety but the mind remains clear and alert Such is the facies Hippocratica, so typical of severe toxæmia The pulse rate has risen to 150 or more but the temperature has fallen to 99° F or even below normal. The retracted abdomen has been replaced by the distension of paralytic ileus but the muscles are still rigid and generalised tenderness persists There is absolute constipation and feculent vomit flows effortlessly from the mouth. There may be retention of urine, which is highly coloured and contains albumen Auscultation meets with silence and percussion may reveal shifting dullness in the flanks

The *prognosis* is always grave and with every hour that passes the prospect becomes more hopeless Early diagnosis of the cause and its prompt treatment will save many patients but any delay will meet with disaster

Differential Diagnosis—The picture of an established case of generalised peritonitis cannot be mistaken, but in the early—and

important—stage much difficulty may be experienced The morbid processes likely to cause confusion are as follows —

1 Thoracic Pleurisy and pneumonia often give symptoms and signs referred to the upper abdomen, and coronary thrombosis may suggest a perforated peptic ulcer or an acute cholecystitis A careful attention to the history and mode of onset together with a *routine* examination of the chest should exclude these diseases

2 Abdominal colic, be it intestinal, biliary or renal. The former can cause great confusion, but the others are recognised by the nature extent and distribution of their pain and tenderness

3 Intestinal obstruction may lead to peritonitis but in the early stages is characterised by pain complete absence of tenderness and rigidity and by greatly exaggerated sounds on auscultation The combination of the history with the negative findings should always prevent any mistake

4 Intraperitoneal hæmorrhage especially when due to trauma may be most confusing at first because the violence may have bruised the abdominal muscles sufficiently to cause rigidity and tenderness The general picture of internal bleeding however soon becomes unmistakable

5 Renal disease Pyelitis may prove misleading but the rapidity of onset with so high a temperature (104 to 105 F) and rigors should prevent error Uræmia sometimes manifests itself as a slowly appearing ileus but the absence of tenderness and rigidity should be conclusive

6 Spinal cord and column. Tabes dorsalis can be misleading when abdominal crises are present and an examination of the pupils and the nervous system alone can prevent mistakes Spinal caries with a psoas abscess may also give symptoms entirely limited to the abdomen.

7 Torsion of an ovarian cyst subserous fibroid or aberrant spleen is among the more rare conditions which may need to be distinguished

In effect the differential diagnosis is that of all acute abdominal disease and it cannot be too constantly or forcibly impressed upon students that, in every case of an abdominal emergency the chest urine and nervous system must invariably be examined.

Treatment.—This consists in the removal or suppression of the cause peritoneal toilet and drainage

Removal of the Cause.—Attention is directed to the particular viscus involved and this receives appropriate treatment The lesion cannot always be removed, but it must be closed or sealed off from further communication with the peritoneal cavity for example a gangrenous appendix will be removed whereas a perforated ulcer will be sealed by suture Such treatment may be regarded as prophylactic, because if done soon enough it will prevent the occurrence of general peritonitis

Peritoneal Toilet.—The inflammatory exudate should be removed as completely as possible consistent with gentleness of handling and absence of exposure of unaffected areas. Very gentle swabbing and better still, aspiration will extract all the fluid if care and patience are exercised The area is then liberally dusted with microcrystalline sulphadiazine

Drainage.—This is a very vexed question and no explanation will meet with general acceptance so diverse are the views held by different surgeons It is better to follow certain general principles In the first place it is completely impossible to drain the general peritoneal cavity for within thirty-six hours the tube is surrounded with coils of intestine and omentum and sealed off by adhesions In the second place the peritoneum is unique among human tissues in its wonderful *powers of defence If the original lesion has been removed or closed* and the irritant exudate extracted, the peritoneum is quite able to look after itself without any external assistance It is only when the cause has not been removed or if certain infective conditions are left behind that drainage becomes necessary These conditions are (a) local abscess (b) retention of cause *e.g* cases of gangrenous appendicitis or cholecystitis in which there has been no attempt to disturb the localising adhesions and a tube has been inserted without further exploration (c) inefficient suture of intestine leading to the fear of a fæcal fistula *e.g* when the cæcal wall is so friable that it will not retain stitches after appendicectomy (d) certain special lesions such as acute pancreatitis, which demand drainage for five to six weeks and (e) all operations in which there is unavoidable oozing of blood.

When a drainage tube has been used, it should be kept *in situ* for not more than five days and then removed. There is no point in *shortening* it daily and if it should be *extruded spontaneously no* effort must be made to reinsert it or a smaller one

After-treatment is directed to the prevention or cure of *paralytic* ileus (p 671) and to the elimination of toxins The patient is placed in Fowler's position and a continuous intravenous drip saline is started immediately on return from the theatre In severe cases it will be wise as a routine to insert a catheter via the nose and aspirate the stomach contents at half-hourly intervals Provided the surgeon is satisfied that the cause has been removed and that all pockets of pus have been drained, the problem is simply that of the ileus Chemotherapy of course will be instituted immediately

Treatment of the Late Cases is practically hopeless, but the cause should be sought for and removed by laparotomy unless the patient is moribund. The peritoneum is carefully cleansed and closed with drainage

Specialised Types of Acute Peritonitis

Pneumococcal Peritonitis is practically confined to young female children under the age of 12 years It occurs in two forms either as a secondary *blood-stream infection during lobar pneumonia or middle-*ear disease or as an ascending infection from the vulva via the vagina, uterus and Fallopian tubes *This latter type is an example of the so-called* primary peritonitis of children." It is usually acute and generalised, but it occasionally produces a subacute local lesion.

Symptoms—If the abdominal condition is secondary to pneumonia, the child is already gravely ill and the pain and vomiting appear *as yet* further dread complications. In the primary type the onset is gradual in a previously well and happy child. Vague abdominal pain ushers *in the*

attack with nausea loss of appetite and possibly diarrhœa. The patient becomes ill very fretful and peevish and within a few days a typical general peritonitis has developed without any suggestion as to its cause

The *signs* differ in no way from those given above but the progress is not so rapid. The abdomen is tender and rigid and the child is obviously gravely ill thin and miserable In the localised form the signs are concentrated over a definite tender swelling in the lower abdomen A vaginal discharge is present in nearly every case and the pneumococcus can be isolated from it

Treatment —If the pneumococcal origin has been proved it is wise to employ expectant treatment, because although the prognosis is always grave the results are better than after laparotomy Full doses of penicillin and sulphadiazine together with blood transfusions hold out the best hope of cure If the nature of the peritonitis is in doubt an exploration must be done and if the thick greenish and odourless pus is recognised as pneumococcal the wound is closed without drainage In every case a swab will be taken for investigation

In the localised abscess also the pus should be evacuated and the wound closed without drainage general treatment and chemotherapy being relied upon to complete the cure

Gonococcal Peritonitis is also confined to the female sex, but in this case it is usually in women during their period of sexual activity It does rarely occur in young children as a complication of infective vulvovaginitis

In women it is invariably the result of coitus with an infected male The infection tends to remain localised to the pelvic peritoneum and is rarely so acute as in the preceding varieties. It spreads to the peritoneum from the Fallopian tubes and there has generally been a history of vaginal discharge and vulval soreness

Symptoms —Some days after coitus the woman complains of nausea and vomiting and then of lower abdominal pain immediately above Poupart s ligament on each side There is constipation, a vaginal discharge with soreness and discomfort of the vulva and frequent painful micturition. On examination there is no abdominal rigidity but tenderness is noticeable above both inguinal ligaments and especially in the vaginal fornices. The temperature is moderately raised (101 to 102° F) and the patient often imagines she has caught a chill.

In the less common cases there may be general tenderness and rigidity indicating that the infection has become a diffuse one

Diagnosis —The presence of a discharge the localisation of pain to the pelvis and the general condition should suffice to raise the suspicion of gonococcal peritonitis It is not always possible however to differentiate the varied causes of pelvic peritonitis and a pelvic appendicitis may lead to great difficulty If real doubt exists it is better to perform an exploratory laparotomy than to overlook a peritonitis of intestinal origin

Treatment —If the diagnosis has been made with confidence operation is definitely contraindicated Treatment of the genital infection by penicillin and later with vaginal pessaries and douches and careful nursing will usually lead to a resolution of the infection.

CHRONIC PELVIC PERITONITIS of gonococcal origin follows either imperfect resolution of an acute attack or arises spontaneously There can be few more tragic diseases than this often transmitted to an innocent girl at marriage It leads to dense adhesions in the pelvis, *chronic pelvic pain with severe dysmenorrhoea and the danger of* intestinal obstruction Within a short time a happy healthy girl has been converted into a fretful and disillusioned chronic invalid. The treatment of these patients presents a grave problem. Every effort must be made to clear up the local conditions but in many cases nothing short of the removal of both tubes and uterus will lead to a restoration to some measure of health and happiness

Streptococcal Peritonitis merits special mention owing to its grave prognosis and its association with puerperal infections. It may be seen also as a manifestation of streptococcal septicaemia and it may dominate the picture in an uncomplicated peritonitis of intestinal origin, *e.g* acute appendicitis In these cases especially in the early stages the effusion is of a dirty blood-stained, serous nature *such a finding during a laparotomy should point to the need for* prophylactic measures against paralytic ileus so common in this type of infection.

There is nothing specific in the way of treatment beyond that already laid down, but when secondary to puerperal sepsis, the genital lesion must receive energetic attention Penicillin and sulphadiazine should be given in large doses by which means an improvement in prognosis may confidently be expected.

LOCAL INTRAPERITONEAL ABSCESS

Collections of pus may occur in any part of the peritoneal cavity and can be divided into those above the transverse colon and omentum (grouped together as subphrenic abscesses) and those below them, these usually localising either in the pelvis or in one or other iliac fossa.

Subphrenic Abscess.

Anatomy—Barnard's classification with slight modifications still holds the field and depends on the anatomical arrangement of the potential spaces beneath the diaphragm and liver These are right and left anterior right and left posterior intraperitoneal spaces and the extraperitoneal bare area on the superior surface of the liver

The right anterior space lies to the right of the falciform ligament and has both a subdiaphragmatic and a subhepatic division. It contains the gall-bladder pylorus and the first part of the duodenum.

The *right posterior space* communicates freely with the above *It lies* below the diaphragm behind the right lobe of the liver round the inferior margin of *which it spreads forwards and joins the anterior compartment.*

The *left anterior space* lies to the left of the falciform ligament and in front of the gastrohepatic omentum, the anterior surface of the stomach and the great omentum.

The *left posterior space* is the lesser sac of the peritoneum which therefore cannot *communicate with any of the other spaces except through the foramen* of Winslow

Etiology—Any of the many causes of peritonitis may eventually lead to the formation of a subphrenic abscess Commonly it follows perforated peptic ulcers appendicitis cholecystitis ruptures of the liver and spleen and occasionally the spontaneous extension of an empyema through the diaphragm

Symptoms—Group I.—**Post-operative subphrenic abscess** may follow any acute inflammatory lesion within the peritoneum Either from ineffectual localisation by the patient lack of removal of the cause or imperfect surgical technique an infective or irritant focus is left undrained beneath the diaphragm The clinical story in such a patient relates to the original illness the operation and a period of from four to seven days during which a steady improvement takes place both the local conditions and the pulse and temperature settling down Then this progress is stayed and an insidious deterioration sets in Pulse and temperature rise there is upper abdominal pain and the patient shows signs of toxæmia

Group II.—**Spontaneous subphrenic abscess** results from perforations of peptic ulcers which leak slowly and become sealed with omental plugs or such acute conditions as appendicitis in which the infection is carried to the subphrenic region by the lymphatics or the retroperitoneal tissues In these cases there will be an interval of ten or more days before the onset of the abdominal pain and signs of a mild toxæmia.

Signs—If the pus is below the liver in front a swelling is apparent below the costal margin and in the epigastrium of the affected side and the diagnosis presents no difficulty this is far from true when the pus lies above the liver deeply buried beneath the diaphragm Nevertheless a careful analysis of the clinical signs should lead to a correct diagnosis The liver is displaced downwards and the diaphragm upwards therefore producing a considerable increase in the dullness on that side a small circular area of gas resonance may be found in this dullness. Above the diaphragm is a small sympathetic pleural effusion and above this a zone of compressed lung above which again will be a typical strip of increased vocal resonance and ægophony In addition, there may be an appreciable bulging of the lower costal area on the affected side and both chest and abdomen move poorly with respiration. A leucocytosis of over 20 000 will point to a collection of pus

Diagnosis should rest between pus above or below the diaphragm. This disease is so much less frequently seen in this era of improved diagnosis that its possible presence may be overlooked but the very obscurity of the clinical picture should suffice to raise the suspicion of subphrenic pus Percussion and auscultation of the successive zones enumerated above will not always clinch the diagnosis but X ray screening will invariably do so The elevation of the dome of the diaphragm which is motionless the absence of any considerable quantity of fluid in the pleura and the upward but not lateral displacement of the heart all point to a subdiaphragmatic lesion

Prognosis is always grave as this relatively uncommon disease points to a breakdown either of the patient's resistance or of surgical technique

Treatment—(1) Prophylactic. Early diagnosis and prompt treatment

of abdominal disease has already led to a great decrease in the incidence of this complication and will do so still further in the future (2) **Active.** The approach for drainage depends on the situation of the pus The anterior subhepatic collections form visible swellings below the costal margin and thus drainage is a very simple matter The incision is made through the oblique muscles just outside the rectus sheath an inch below and parallel to the costal margin

The subdiaphragmatic abscesses must be drained from behind without traversing the pleural cavity The 11th or 12th rib is resected through an incision outwards from the edge of the erector spinæ The diaphragm is incised low down below the limit of the pleura. The finger enters the perinephric fat and works its way upwards following the abdominal surface of the diaphragm. The abscess is thus opened without traversing either the pleura or the unaffected peritoneum.

The transpleural route should be employed only when other routes are impossible as its mortality rate is unduly high

Pelvic Abscess.—These are far more common in women than in men, owing to the liability of the female genital organs to infection. Thus in women the causes are salpingo-oöphoritis, puerperal and abortional sepsis (including the penetrating wounds of the vaginal fornix in criminal cases) torsions and strangulations of ovarian cysts or pedunculated fibroids, and finally secondary infection of the hæmatoma following an ectopic gestation. Common to both sexes, appendicitis and diverticulitis are frequent causes while infected peritoneal exudates from any area may flow downwards and give rise to an abscess in the pouch of Douglas

Clinically therefore these conditions may be post-operative or spontaneous, there being little difference between them except for the operation. There will be a history of the causative disease followed by operation or a period of apparent resolution. Then there is a falling off in the improvement and the patient begins to complain of low abdominal pain, vomiting, frequency and possibly difficulty of micturition and pain or difficulty when the bowel acts or an aperient is given. Examination reveals tenderness above the pubes and one or both Poupart's ligaments whilst vaginal or rectal examination encounters the bulging tumour which is tender

Treatment—There is no necessity for early operative interference provided the pulse rate and the general condition remain satisfactory for these abscesses frequently burst into the rectum. A careful watch is kept hot rectal and vaginal douches and short-wave diathermy are given. As soon as the rectal wall is getting thin, an opening should be made into it through a speculum and a small drainage tube introduced. Similarly but more rarely these abscesses point towards the posterior vaginal fornix and may be drained by a posterior colpotomy

Iliac Abscesses in the right and left iliac fossæ result from appendicitis in the former case and diverticulitis in the latter Nothing special need be said about them except that their prevention requires early diagnosis and treatment, and should they form simple incision and drainage with or without removal of the cause will be called for the details of which will be found under the heading of the respective diseases

CHRONIC PERITONITIS

Simple Chronic Peritonitis is rare apart from tuberculosis but certain forms are described which are apparently not due to the Koch s bacillus

An aseptic chronic variety is reported though it is exceedingly rare It is believed to occur in connection with the retention of a sterile foreign body within the peritoneum especially after operations Eventually after a period of ill health the patient succeeds in extruding the foreign body either via the rectum or the abdominal wall.

Chronic generalised peritonitis is a very rare condition. A thick gelatinous membrane is formed over the small intestine which leads to dense adhesions Symptoms of mild chronic intestinal obstruction occur with a state of chronic invalidism No treatment is indicated unless obstruction supervenes when the task confronting the surgeon may well prove insuperable

Chronic localised peritonitis is also rare apart from tuberculosis Plastic adhesions may form around any variety of intestinal disease but this does not constitute a primary chronic peritonitis It is quite evident from the published descriptions that the majority of these cases are in fact examples of the chronic type of regional ileitis (Crohn s disease) which have not been recognised as such by the authors.

TUBERCULOUS PERITONITIS

Tuberculous peritonitis may occur in either sex at any age but the first fifteen years of life provide the majority of cases while after puberty most of the patients are young females The infection may reach the peritoneum in several ways (a) via the intestinal canal, the bacilli having been ingested with infected milk (b) by direct spread from any focus in the neighbourhood, such as genito-urinary infections spinal caries, psoas abscess etc (c) by extension to the pelvic peritoneum from the Fallopian tubes in young women or (d) it may be a blood or lymph borne infection from the lungs cervical or mediastinal glands or from any other tuberculous lesion in the body

Acute Miliary Tuberculous Peritonitis is hardly of surgical interest, and is dealt with in textbooks of medicine It is always part of a terminal infection and no treatment is of any avail.

Chronic Tuberculous Peritonitis is unhappily a very common manifestation of the disease, especially among children and young girls It may take several forms namely (1) ascitic (2) encysted or loculated, (3) adhesive and (4) purulent

The Ascitic Type.—The peritoneum is thickened and studded with tubercles and adhesions are present between coils of intestine while the great omentum is thickened and rolled up so that it forms a transverse band across the abdomen just above the umbilicus. There is a profuse clear straw-coloured effusion, which contains tubercle bacilli There may be active lesions of tuberculosis in other parts of the body

Symptoms—The child is ill, thin and fretful but although there may be some abdominal discomfort the symptoms are usually slight The effusion is slow in onset and the picture is one of a progressive loss of health and vitality

Signs.—The body is thin and the muscles are wasted, while the abdomen is prominently distended, the skin being tense and shiny and blue veins are to be seen coursing beneath the thin skin. All the classical signs of fluid are present: the shifting dullness in the flanks, a central area of resonance and a fluid thrill. Deep palpation reveals doughy masses formed by adherent coils of intestine and the transverse band of omentum is clearly defined. There is an evening rise of temperature and the face has the clear lustrous skin with its hectic flush and the eyes have the brilliance which are associated with tuberculosis.

Diagnosis should not be difficult owing to the age of the patient, such lesions as the ascites of cirrhosis of the liver and of generalised carcinoma of the peritoneum being seen at a much later period of life.

Treatment is essentially institutional and surgical intervention should be avoided. The practice of opening the abdomen and letting out the fluid has little to recommend it and should be adopted only if the distension is so great as to be a serious embarrassment. Streptomycin will be used in all cases.

The Encysted or Loculated Type occurs in children, but more frequently in young women. A definite tumour is formed consisting of coils of intestine matted together enclosing a loculated cavity containing a serous effusion. Tubercles and a thickened peritoneum are present in the affected area but the rest of the peritoneum is normal.

The localisation in the peritoneum is an indication of the successful resistance on the part of the patient, and in this type the general health remains good for long periods. Vague abdominal pain may have been present for some time and on examination a discrete mass can be felt usually in the lower part of the abdomen. If left untreated, the general condition deteriorates and there is a danger of intestinal obstruction, fistula formation between the coils or more serious still, secondary infection from leakage of bacteria from the intestines. For these reasons if the local condition does not respond rapidly to sanatorium treatment, this type of tuberculous peritonitis should be operated upon, the tumour mass explored and dealt with in accordance with the findings, the abdomen being closed without drainage.

The Adhesive Type is less common than the ascitic. The abdominal contents are adherent to each other so as to form one mass from which it is wellnigh impossible to disentangle the composite parts. There is *little or no effusion. Fistula formation is common in the later stages.*

The *clinical picture* is one of gradually increasing weakness, wasting and abdominal pain, on which may be superimposed at any time symptoms of chronic or even acute intestinal obstruction. The abdomen is not distended, moves on respiration and is not tender but palpation reveals such characteristic findings that the diagnosis is *unmistakable. Although difficult to differentiate local swellings* there is a nodular doughy sensation over the whole abdomen and the rolled up omentum may be palpable. The impression is that of a generalised soft resistance without any muscular rigidity.

Treatment is entirely medical and surgical interference can be justified only in the presence of obstruction and the outlook then is almost hopeless.

The Purulent Type is very rare and is secondary to tuberculous salpingitis in young adolescent females True tuberculous pus is found in the pelvis and the condition is an acute one The girl complains of low abdominal pain rapidly wastes and becomes seriously ill. Treatment in these lesions is always surgical with the removal of the diseased tube and ovary

General Prognosis varies with the type the ascitic and encysted forms holding out high hopes of recovery under the full régime of sanatorium treatment In the adhesive type the outlook is grave and the mortality high

General Diagnosis should never be really difficult The encysted forms are frequently regarded as ovarian cysts but in the generalised types the age and appearance of the patient and the clinical signs are such as should raise the suspicion of tuberculous peritonitis before any other disease

GUMMATOUS PERITONITIS is a rare manifestation of tertiary syphilis and still more rarely it may be seen as a congenital lesion The peritoneum is thickened and there is ascites The treatment follows general antisyphilitic lines

R M HANDFIELD-JONES

ABDOMINAL INCISIONS

Certain general principles should be borne in mind in opening the peritoneum through the anterior abdominal wall. The incision should be large enough to give full exposure of the field concerned and so planned as to be capable of extension if required. The access provided should be as direct as possible Permanent injury to the abdominal wall comes chiefly from damage to its nerve supply In general incision through aponeurosis or fibrous layers with retraction or splitting of muscles does less harm than cutting across muscle fibres but if this latter is necessary to give good exposure little harm results providing subsequent suture is accurate

Skin edges should always be protected by sterile towels before the peritoneum is opened. Opening is done by lifting the peritoneum in dissecting or artery forceps inserting two fingers and cutting up and down with knife or scissors The abdominal wall should be carefully closed by layers—the peritoneum by a continuous catgut or silk stitch on a round bodied needle the musculo-aponeurotic layers by a continuous stitch on a cutting needle and the skin by interrupted or continuous silk worm gut according to the operation being performed. In any fat or weak abdominal wall it is wise to reinforce the skin sutures with tension sutures passing from the cutaneous surface a little distance from the incision on one side through the musculo-aponeurotic layer of that side and out through similar layers to a corresponding position on the opposite side

Abdominal incisions fall into three main groups —

A VERTICAL INCISIONS

1 **Paramedian.**—Parallel to and about an inch lateral to the midline through the anterior sheath of the rectus, which muscle is retracted laterally to expose the posterior rectus sheath This latter is opened together with the peritoneum

2 **Midline.**—Such incisions have the advantages of giving a rapid approach and of being relatively bloodless—but this latter factor produces a tendency to bad healing This drawback is particularly noticeable above the umbilicus where the recti tend naturally to divaricate Below the umbilicus it is the favourite gynaecological incision

3 **Pararectal.**—Incisions parallel to the outer border of the rectus have the disadvantage of jeopardising the nerves entering the sheath. The classical example is the 'Battle' incision used chiefly for access to the appendix especially when some pelvic exploration is also likely It is made 1 in. internal to the linea semilunaris and is 3 to 4 in long with its centre on the line joining anterior superior spine to umbilicus The anterior rectus sheath is incised, the muscle retracted inwards and the posterior sheath and peritoneum opened between the 11th and 12th dorsal nerves.

4 **Muscle Split.**—Incision over the middle of the rectus sheath th anterior layer of which is incised, the muscle split in the direction of it fibres and the posterior layer of the sheath exposed and opened with the peritoneum in the same line

B OBLIQUE INCISIONS

1 **Kocher's Subcostal Incision** for exposure of the gall bladder and bile ducts, extends from the tip of the xiphisternum parallel to and 1 in. below the costal margin to a point laterally in the anterior axillary line The rectus (sheath and muscle) is cut across between the 7th and 8th intercostal nerves, the latter being in some danger if the incision is prolonged too far laterally Although said to be conducive to subsequent incisional hernia this in practice is not found to be the case On the left side it may also be employed for access to the spleen and splenic flexure of the colon.

2 **Oblique Kidney Incision.**—Extending from the point posteriorly where the 12th rib and the lateral border of the erector spinae meet following forward an inch above the iliac crest to a point anteriorly opposite the anterior superior spine For further details see Kidney Operations (p 787)

3 **McBurney or Gridiron Incision.**—A common means of access to the appendix McBurney's Point is at the junction of the outer third and inner two-thirds of a line joining anterior superior spine to umbilicus and McBurney's incision is at right-angles to this line at this point, the incision being 3 in. long two-thirds of it above the line and one-third below T aponeurosis of the external oblique is incised in the same direction and a slightly greater extent than the skin, the internal oblique and transversal muscles are then plit at right-angles to the skin incision (i.e in the directio of their fibres) and held apart by retractors while the underlying peritoneum is opened. Suture of the muscular layers is unnecessary the external oblique aponeurosis being united by a continuous suture

C TRANSVERSE INCISIONS

Where necessary the rectus can be cut across horizontally without any loss of ultimate function or risk of herniation provided accurate suturing of its sheath is carried out during clo of the abdomen. The result is simply an added (su cal) linea t Similarly the obliques can be cut across as in th expos access to the spleen or colon flexures or in fo lostom (Again subsequent accurate suturing is essent

CHAPTER XXVII

HERNIA

SURGICAL ANATOMY

DEFINITION.—According to one authority the word "hernia" is derived from the Greek "Ernos," meaning a bud or sprout, a perfect description of the appearance of a hernial sac. The Oxford Dictionary, however, gives a Latin derivation and translates it as a rupture. The definition given is: "A tumour formed by the displacement and resulting protrusion of part of an organ through an aperture, natural or accidental, in the walls of its containing cavity."

This definition is very exact, but it implies a knowledge that the cavity possesses first a lining membrane and second a wall so designed that it will resist the varying changes of pressure within it. It is such disturbances of pressure within the peritoneal cavity which force a portion of its contents into either a preformed sac (natural or congenital) or an acquired sac (accidental).

The clinical picture, diagnosis and treatment of all forms of peritoneal hernia are so consistently interwoven with a knowledge of the anatomy and mechanics of the abdominal musculature that a brief account of these must be given.

THE WALLS OF THE ABDOMINAL CAVITY

These are bony and muscular. The osseous components consist of two portions: first, a central strut formed by the last dorsal, lumbar and sacral vertebræ, together with the 12th rib and pelvic girdle, which give origin to the majority of the abdominal muscles; and secondly, the 6th to 11th ribs, which form a movable lattice framework giving insertion to most of these muscles. This central strut and the pelvic girdle therefore form a rigid basis upon which the movable thorax with its inserted muscles can exert their pull.

The peritoneal cavity can be regarded as having five normal boundaries (Fig. 271), viz. superior, inferior, posterior, lateral and anterior.

The Superior Wall is formed by the diaphragm, the two crura of which take part in forming the posterior abdominal wall.

The Inferior Wall consists of the pelvic floor, which is hammock shaped, being composed not only of the levatores ani but of fibromuscular tissues of great strength. This floor is liable to be weakened

thereby enabling it to interdigitate with the diaphragm. The internal oblique using this sheet as a basis interdigitates with the intercostal muscles. The external oblique has a free posterior margin but its inferior border forms the inguinal (Poupart's) ligament. This passes from the anterior superior iliac spine to the pubic spine and is then continued backwards and outwards along the ileopectineal line to form the lacunar (Gimbernat's) ligament. The transversalis and internal oblique muscles arise not only from the iliac crest but also from the outer half of the inguinal ligament. Then by means of the conjoint tendon they gain a weak attachment to the inner half of this ligament and a firm insertion into the symphysis pubis and the ilio-pectineal line medial to and blending with Cooper's ligament. It is obvious that in contraction the main pull of these muscles is upon the linea alba, linea semilunaris, inner half of the inguinal ligament and the lumbar vertebræ. This pull is on a curved plane transversely and falls first upon the linea semilunaris and thence to the linea alba. At and above the umbilicus tendinous intersections of the rectus help to bind these two lines together and thereby resist the transverse pull. Below the umbilicus the pyramidalis muscle aids the recti to prevent their divergence.

The Value of the Interdigitations.—The construction of the abdominal wall ensures that movements of the abdomen are intimately connected with those of the thorax. It is impossible to raise pressure *in one cavity without altering it in the other.* *The diaphragm gives* a degree of independence to the two cavities in quiet but not in forcible movements such as coughing and straining, in which the whole thorax and abdomen are acting against the resistance of the pelvic girdle and floor.

The diaphragm and transversalis muscles can be considered as an entity which effects a squeezing action upon the abdominal contents. During their action there will be a tendency for the lower thorax to cave in, but the lower six ribs resist this collapse and this is further opposed by the internal oblique interdigitating with the intercostals and so acting as a tensor between thorax and pelvis. This bracing action is reinforced by the interdigitation of the external oblique and serratus magnus, and of the rectus abdominis with the pectoralis major. In this way the thorax is firmly held and the maximum squeezing force brought to bear on the abdominal contents.

In the erect and sitting postures this force is expended upon the iliac fossæ and pelvic cavity. As this latter is filled with various organs including the ileum a cushioning effect occurs with the result that the main brunt of this squeezing force is thrown against the para-psoas gutters and in consequence against the inner half of both inguinal ligaments at a site where both inguinal and femoral canals are placed. When the knees are drawn well up on to the abdomen this region is protected and forcible straining will then fall upon the pouch of Douglas in the male and the posterior vaginal fornix in the female. Provided the pelvic floor is intact, this pressure causes venous congestion and eversion of the anal canal in both sexes.

Anatomy of the Hernial Sac

With the exception of a sudden giving way of a recent surgical wound all herniæ are preceded by a diverticulum of peritoneum called the sac In insidious yieldings of surgical scars, a false sac may be formed from the peritoneal edges at the margin of the rupture

The Aperture is defined as the margin of the opening through which the sac has passed At this point therefore the latter becomes continuous with the general peritoneal cavity and in consequence this part of the sac is known as its *neck* The narrower the aperture and the more rigid its margins the more dangerous is the hernia as strangulation of the contents is likely to occur

Congenital apertures occur at the umbilicus inguinal canals and diaphragm and it is probable that persistence of the sac has prevented adequate closure of the aperture Acquired apertures result from violence or necessitous surgery in war wounds an example is provided by injuries to the diaphragm while in civil surgery non union of tissues in surgical incisions especially at the site of drainage tubes is a common cause of acquired herniæ

Contents of the Sac—With the sole exception of the pancreas no abdominal organ is exempt from the possibility of entering a hernial sac. The commonest structure to migrate is the omentum and next a portion of ileum According to the variety of hernia—the cæcum transverse colon pelvic colon and bladder follow in order of frequency As the sac increases in size so do the volume and character of its contents and it is not uncommon to see omentum and both small and large intestine presenting in the same sac

Causation of Hernia

The exact causation remains a matter of dispute some authorities maintaining that all herniæ are congenital a bud of peritoneum not being withdrawn or obliterated but remaining *in situ* providing a potential space for further changes (Fig 274) It cannot be disputed, however that some herniæ are acquired even at those sites which are considered to be most frequent for congenital sacs

The existence of a sac does not necessarily imply the presence of contents The rupture first comes down as a result of sudden or persistent increase in intracœlomic pressure the commonest of which is straining against resistance during normal or abnormal work or during the performance of a normal function in face of difficulty particularly defæcation and micturition

Congenital Hernia.—In addition to those occurring in the inguinal and umbilical regions, some authorities consider all femoral herniæ to be congenital. Many undoubtedly are but others appear to be acquired Developmental defects in the diaphragm provide other sites for congenital lesions which are less infrequent than is generally supposed

Exaggeration of natural folds in the peritoneum of the posterior abdominal wall particularly in relation to the superior mesenteric artery and vein is a well recognised cause of intraperitoneal hernia.

Acquired Hernia is of three types—spontaneous traumatic and infective

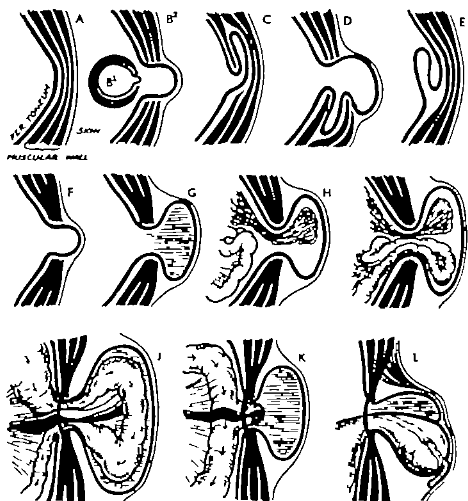


Fig. 274

The processes involved in hernial sac formation.

The diagrams illustrate the varieties of hernial sacs, the hanges which occur in their contents, and the manner in which sepsis may produce incisional hernia.

A, normal relation of peritoneum to the layers of the bdominal wall. B1 the sac is a bud of the lining membrane B2 common type of hernia and its perture C. interstitial hernia. D hernia with diverticulum which is interstitial. E, intra peritoneal hernia. F the sa ma be empty G fluid—hydrocele of a hernial sac I peritonitis pus may be present H, omentum only—epiplocele or omentocele I, omentum and intestine. Omentocele and enterocele Note that the omentum lies in front and superficial to the intestine J a loop of intestine is strangulated. Not the changes in the intestine and the vessels, nd the fluid present in the sac K, portion of the lumen is involved. Richter hernia. L, hernia gl and Not the sac is abov and in front

Spontaneo ... tion pulsion or a combination of the two Th ... y due to pulsion Traction herniae are common ... pomata Fat has the remarkable

property of oozing through small apertures and pulling neighbouring structures with it and small lipomata often initiate the process of sac formation Similarly the great omentum creeps through the neck of a small sac widening and enlarging it

Traumatic hernia is seen in surgical incisions and is due either to the whole of the incision giving way or to one or more portions of it failing to unite

Inflammation is a rare cause of hernia except in its association with surgical incisions An abscess of the abdominal wall occasionally so destroys the tissues that an aperture is formed through which herniation may occur

Medico-legal Aspect—An employee can obtain compensation when it is proved that his work was the cause of his hernia It is sometimes difficult to prove or disprove that an occupation was the cause or even a provocative agent of the hernia In investigating such cases a most detailed history of the occurrence must be taken In practice the workman is almost always given the benefit of any doubt

COMPLICATIONS OF HERNIA

The complications to which any hernia is subject are —

1 Irreducibility	4 Strangulation
2 Hydrocele of sac	5 Incarceration
3 Torsion of omentum	6 Infection.

Irreducibility is due to many causes. A plug of omentum may become impacted in a narrow neck and consequently œdematous It is then too large and rigid to retrace its steps Adhesions may form either between the sac and its contents or between the contents themselves. A truss by ill placed pressure may cause constriction of the neck of the sac Other causes are excessive deposition of fat in the omentum fæcal impaction and strangulation

Hydrocele of the Sac.—If the neck is unduly narrow and omentum plugs it but does not penetrate far into the sac a fluid exudate from the œdematous omentum may cause a hydrocele of the sac (Fig 274 a)

Torsion of the Omentum may also occur the signs and symptoms of which are indistinguishable from strangulation

Strangulation occurs when the contents passing through the neck are of such volume that the vessels supplying them are compressed This may happen upon the first occasion in which abdominal contents are propelled into the sac In older patients it is usually due to additional contents being thrust into the sac by unusual violence of effort such as lifting heavy weights coughing sneezing and straining at stool

The *pathology* of strangulation is fully discussed in Chap XXX on p 659 in connection with acute intestinal obstruction similarly the signs symptoms diagnosis and treatment of strangulated hernia are described in the same section of this book

Incarceration is more commonly seen in a left inguinal hernia occupied by a portion of the sigmoid colon There is no interruption

with the blood supply but fæcal material becomes stagnant within it and fluid is absorbed As more fæces enter their bulk is so great that not only does the rupture become irreducible but chronic intestinal obstruction from fæcal impaction is likely to follow

Infection of the Sac is an unusual phenomenon It is seen when the appendix lying within the sac becomes acutely inflamed other causes are Richter s hernia and Meckel s diverticulitis within a sac (the so-called Littre s hernia)

Examination of the Patient

The examination falls into two parts, local and general the former to determine the type of hernia present the latter to assess the general constitutional condition of the patient and to collect data upon which an opinion as to treatment may be based First however a careful history will have been taken

Symptoms —A patient with an external hernia without complications will complain of pain and swelling Pain is most marked upon the first occurrence of the hernia and becomes progressively less as time goes on, as the contents descend more frequently and as the neck becomes sufficiently stretched to tolerate the passage of contents into the sac Swelling is persistent or intermittent if the latter it may be absent while the patient is at rest and appear only upon standing or straining

Internal hernia is unlikely to give symptoms until complications set in.

Local Examination — *A* **Of the Hernia.**—The patient should first be lying upon a couch Each hernial aperture is inspected and palpated particular attention being directed to the suspected site

If reducible the contents of the sac will disappear within the abdomen either spontaneously on lying down or by manipulation Omentum is silent when reduced, but the intestine gurgles and squelches palpably and sometimes audibly in a very characteristic way If the patient is asked to cough or strain thereby raising the intra-abdominal pressure the swelling reappears. It is then surrounded by the fingers of one hand and the patient again asked to cough when an expansile impulse tends to separate the examining fingers and to push them a *little farther from* the abdominal wall As the force expends itself the fingers resume their original position. This is the well known sign— the impulse on coughing

If a hernia is partially reducible it is usually the intestine which returns either completely or in part the omentum remaining within the sac

Attention is turned to the aperture and to the muscles in the immediate neighbourhood

B **The Abdominal Musculature.**—The patient is now asked to stand erect facing the surgeon who is seated This part of the examination must be conducted with the patient first in relaxation and then in activity The routine consists in observing and examining each potential hernial site general build of the trunk degree of physical fitness

obesity and posture Each set of muscles is actively contracted in turn, and in this way each group of structures will be thrown into relief or in the presence of much fat their outlines should be palpable This examination should proceed in the following order—linea alba rectus abdominis muscles, linea semilunaris inguinal canals femoral regions lateral and posterior abdominal walls. This technique throws the hernia if present into bold relief it also gives correct information as to the contents of the scrotum and the presence or absence of varicose veins

General examination is directed towards the assessment of the patient s chances of deriving benefit from an operation Diagnosis has already been achieved what advice is the surgeon to give ? Attention is directed first to the cardiovascular system with regard to the state of the heart and blood pressure to the respiratory system to exclude all conditions causing a persistent cough to the alimentary system with regard to constipation, distension and hæmorrhoids to the urinary system to recognise any form of chronic urinary obstruction, such as phimosis enlargement of the prostate or urethral stricture Lastly it is necessary to exclude any infective conditions in the vicinity of the hernia which might lead to sepsis occurring in the operation wound

General Principles of Treatment

The possibilities in treatment may be summarised as follows —

Reducible hernia—(*a*) truss or belt and pad, (*b*) injection (*c*) operation.

Irreducible hernia which is not strangulated—operation.

Irreducible hernia which is strangulated—(*a*) taxis and if this fails, (*b*) operation

As a general statement it may be said that all patients with an irreducible hernia are in danger of intestinal obstruction Secondly even if the risk is high before the onset of strangulation, it is better to operate than to wait until that risk has been made desperate by the presence of intestinal obstruction Thirdly with the exception of certain cases of umbilical hernia in children no rupture can be considered as permanently cured by the wearing of a properly fitting appliance Fourthly as a patient ages the more does his abdominal wall stretch and his intra-abdominal pressure increase Fifthly pulmonary intestinal or urinary complications make the wearing of a truss less satisfactory and the occurrence of strangulation more likely

Truss.—A truss can be fitted only to a reducible hernia Its essentials are that it should be of reasonable price hard wearing comfortable relatively waterproof and control completely the hernial aperture so that contents cannot enter the sac A great many excellent trusses are on the market and because one type does not suit a patient it does not necessarily follow that another will be unable to do so In certain patients it is wise to combine the truss with an abdominal belt the use of which is necessary in median paramedian and lumbar herniæ

A bilateral truss should always be ordered if there is a weakness *of the opposite side and this should be a routine in patients doing heavy* work since a unilateral truss may encourage a hernia of the opposite side in heavy manual labourers

A truss having been ordered the surgeon must satisfy himself that it is a perfect fit not only at rest but in the presence of active movements. Each patient must be instructed to wear the truss upon all occasions, except for sleep at night and in elderly people a light truss even then is advisable A special rubber-covered truss can be obtained for bathing

Injection Treatment.—The injection of sclerosing fluids has been practised in recent years and many thousands of cases are reported from America and elsewhere in which results comparable with surgery have been claimed, with the added advantage that treatment is ambulatory Cases for injection must however be carefully selected. It is essential that the rupture should be completely and easily reducible and kept so reduced by a truss during the entire period of treatment *i.e. night and day The object is to produce an aseptic fibroblastic* reaction around the emptied sac by injections of a sclerosing solution every third day Eventually a mass of fibrous tissue is said to close the sac and obliterate the canal by adherence of its fibrous layers thus curing the hernia. Complications are not frequent but include painful scarring swelling of the testicle impotence and gangrene further any subsequent operation is rendered somewhat more difficult. It cannot be said that this method has met with favour in this country although a number of distinguished surgeons have given it an unbiased and fair trial

Taxis consists in manual reduction of an obstructed or strangulated hernia *It is folly to attempt this procedure without* proper *preparation* for immediate operation should the effort fail

To be successful taxis must be painless and the muscles relaxed. Whether the patient is young or old an adequate dose of morphia and atropine is given to diminish peristalsis and spasm, relieve pain and relax the muscles of the aperture Until the morphia has reached its full effect an ice-bag should be placed over the sac.

In babies and young children the legs should be slung to a gallows splint and the end of the bed tilted a procedure which rarely fails to reduce the hernia In adults a large pillow is placed under the knees and the end of the bed is raised on high blocks.

Taxis must be applied early and it is dangerous to use force greater than firm pressure The sac is squeezed gently between the fingers of both hands, and the contents of the bowel if possible reduced through its lumen. The contents of the sac are then reduced not from the fundus but by degrees from the neck The direction of reduction necessarily follows the anatomical course of each individual hernia The dangers of taxis are obvious viz. rupture of the bowel at the apex or neck, reduction *en masse* *i e* of the whole sac and its unreduced contents (Fig 2‑5) and interstitial reduction If it is successfully accomplished, the patient should be kept in bed under careful observation for three days

Surgical Treatment.—The methods available are (1) herniotomy i.e removal of the sac (2) herniorrhaphy i e removal of the sac and suture of the aperture (3) hernioplasty in which autogenous living suture material (fascia lata) is used to repair the aperture

The results of operation are less satisfactory than they should be a high percentage of recurrences following imperfect surgery It should be remembered that a hernia occurs because either a natural valve has become incompetent (cf indirect inguinal hernia) or a tendinous structure has given way (as in direct inguinal hernia) further it is not possible for a surgeon to recreate an efficient muscular valve The general principles therefore underlying all operations upon hernia will be the provision of as rigid a support as possible in place of the deficient valve or damaged aponeurosis Where there is no loss of tissue and apposition without tension is possible silk suture should suffice If apposition cannot be obtained without tension the gap must be filled in with autogenous material such as fascia lata strips or whole thickness tensioned skin grafts The alternative is unabsorbable material such as tantalum gauze nylon or one of the acrylic resins



FIG 275

Dissection of the abdominal wall looked at from the peritoneal aspect. The rod lies in the internal ring. The sac which has been reduced *en masse*, lies in the retroperitoneal tissues immediately below it.

In babies a simple herniotomy is usually satisfactory the internal oblique and transversalis muscles recovering their normal sphincter action In a small number of adult patients in whom there is no fault in their abdominal musculature similar methods may suffice but for the majority herniorrhaphy or hernioplasty will be necessary to obtain sound repairs No matter what age the patient adequate preparation to avoid post-operative complications and to facilitate sound healing will amply repay both patient and surgeon

INGUINAL HERNIA

Surgical Anatomy—The formation of the inguinal canal is intimately associated with the descent of the testicle This process is described on p 832 As the testicle passes through the layers of the abdominal wall a valvular or semisphincteric arrangement is produced by the characteristic arching of the conjoint tendon (Fig 276)

The relations of the inguinal canal are —

Anterior Wall aponeurosis of external oblique origin of internal oblique in the outer half of the canal.

Posterior Wall transversalis fascia insertion of conjoint tendon in inner half of canal

Floor is the gutter formed by the inguinal and lacunar ligaments.

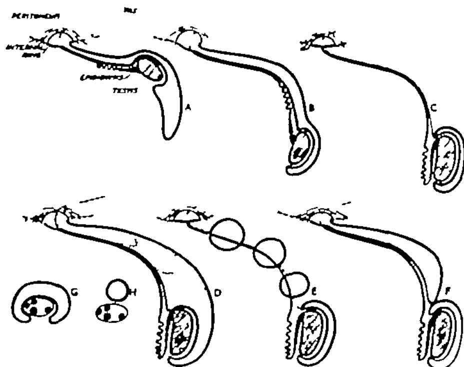


FIG. 276

The relation of the peritoneum to the descent of the testis. The potential sites of hernia and hydrocele formation.

A, the preceding peritoneum during testicular descent. B, patent processus vaginalis. C, complete or normal closure with the epididymis applied to the testis. D potential sites of hernial sac formation. E, potential sites of hydrocele formation. F common type of infantile hernia. G, a cross-section of the cord in a congenital sac. Note the sac nearly surrounds the cord. In the female the round ligament constantly shows this same relationship. H, the relation of the acquired sac to the cord.

Indirect Inguinal Hernia

The sac lies within the normal coverings of the spermatic cord and invariably lies in front of it (Fig 277) In the female the round ligament takes the place of the cord A congenital sac may be either complete in which both processus and tunica vaginalis remain patent in their whole length or incomplete when the processus is patent, but the tunica has been properly shut off The neck is situated at the internal abdominal ring and has the deep or inferior epigastric artery as a constant posterior relation Small sacs do not always emerge from the external abdominal ring and this type of hernia is sometimes known as a bubonocele

Many authorities maintain that all indirect inguinal herniæ are congenital in origin abdominal contents entering a preformed sac no matter at what age the rupture first appears This is probably true of the great majority and may possibly be so of them all Others hold that a sudden protrusion of a sac can occur as a result of an abrupt rise of abdominal pressure combined with poor muscular protection This type of hernia is common in both sexes more so in the male is frequently bilateral but when unilateral is slightly more common on the right side It is seen at any age but the majority first appear in childhood and young adult life



Fig 277
Part of the abdominal wall showing the inguinal canal, the femoral vessels and the spermatic cord The sac of an inguinal hernia is seen projecting from the external ring lying in front of the spermatic cord.

Clinical Signs —The signs and symptoms are those of hernia in general When small it will be confined to the inguinal canal and not protrude beyond the external ring Such a hernia will disappear in recumbency and reappear upon standing coughing and straining Large herniæ come through the external ring and descend into the scrotum (Fig 278) In this stage they are occasionally confused with a hydrocele but this mistake should never be made The upper part of the swelling should be surrounded by the fingers of the hand at the entrance to the scrotum If the thumb in front meets the fingers behind with only skin and spermatic cord interposed, the condition cannot be a hernia descending from the abdomen



Fig 278
Large indirect inguinal hernia filling right side of scrotum and using retraction of penis.

Uncomplicated inguinal hernia give few if any symptoms In the earliest stages patients may complain of pain but later merely discomfort and a certain degree of mental apprehension as to future possibilities A strangulated hernia suddenly becomes the seat of acute pain and tenderness and the general symptoms and signs of acute intestinal obstruction supervene

Direct Inguinal Hernia

This is a rupture through the posterior wall of the inguinal canal being preceded by a rent in the transversalis fascia The sac emerges between the inguinal ligament below and the arching fibres of the conjoint tendon which it displaces upwards As seen from the peritoneal aspect the sac protrudes from the lower part of Hesselbach s triangle It appears above the spermatic cord and displaces it downwards.

In this hernia the neck is usually wider than the fundus and is therefore rather a bulging of the peritoneum than a true hernia It *carries with it extraperitoneal structures of which the bladder is likely* to be a medial relation only when it is large can the sac be really described as having abdominal contents

Clinical Signs—This hernia usually occurs abruptly and with considerable pain It is truly acquired and occurs most commonly in middle-aged stout plethoric working men after some sudden muscular strain Rarely it is seen in young people who have a long back and correspondingly long abdominal wall good but thin muscles and a con genital widening of the space between the lower margin of the conjoint tendon and the inguinal ligament It is not uncommonly bilateral

It will be recognised as a diffuse rounded bulge over the inner half of one inguinal ligament When large it will project forward, and although unusual a direct sac can descend into the scrotum lying in front of the testicle and cord.

It may be confused with an indirect inguinal hernia in old long standing cases of which the internal and external rings have become superimposed by the drag of a large rupture In such cases the relation *ship of the deep epigastric artery gives the diagnostic clue* In direct herniæ this vessel is lateral to the neck, whereas in indirect ruptures it lies medially

Not infrequently an indirect and a direct hernia are present in the same patient—the so-called saddle bag hernia

INTERSTITIAL INGUINAL HERNIA

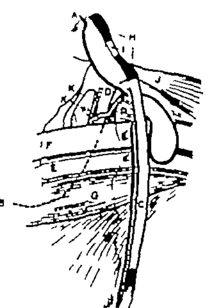
In this rare form of hernia the sac lies between the various layers of the abdominal wall *Three varieties are described* —

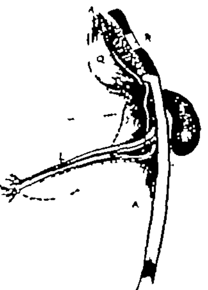
1 Extraparietal hernia in which the sac lies between the skin and external oblique aponeurosis

2 Interparietal in which the hernia passes upwards and outwards between the external and internal oblique muscles and

3 Intraparietal or properitoneal between the peritoneum and transversalis fascia

The last variety is misleading and dangerous since there is no external swelling to betray its presence and strangulation within it is likely to pass unrecognised In the other two varieties an external swelling is visible and palpable In all three imperfect descent of the *testis is usually coexistent*





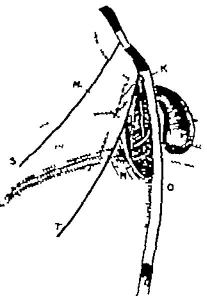


FIG 279

The anatomy of a femoral hernia.

The view taken is a diagrammatic explanation of the viewpoint of surgeon approaching a femoral hernial sac on the right side the surgeon standing opposite the anterior superior spine and looking down upon the structures he is exposing in an operation through the supra-inguinal route.

A peritoneum
B, ileopectineal line
C inguinal ligament.
D, lacunar ligament.
E femoral artery
F femoral vein.
G psoas and iliacus.

H, pubic spine.
I symphysis.
J adductor longus.
K, obturator artery
k abnormal obturator artery
L, epigastric vein and artery
M, trans. and conjoint tendon.

N internal oblique.
O, trans. fascia.
P pectineus.
Q bladder
R, prevesical fat.
S, line of linea alba
T linea semilunaris

HERNIA EN GLISSADE

This curious type of rupture most commonly occurs in the inguinal canal, but is occasionally seen in femoral herniæ The organs usually involved are the cæcum and appendix on the right the sigmoid colon on the left and the bladder on either side But these do not enter into the sac in the ordinary way but lie behind it appearing to slide down the canal with the peritoneum reflected off their anterior surfaces to form the neck and posterior wall of the sac As a result the condition clinically appears to be an ordinary indirect inguinal hernia, but in fact the sac is empty and the contents " extraperitoneal. This type of hernia is rarely recognised before operation It occurs in middle-aged people is usually irreducible but rarely strangulated.

In any form of strangulation the surgeon should open not the fundus but the anterior wall of the sac close to the neck. This is of paramount importance in this type of hernia If the fundus is incised the cæcum, colon or bladder may be accidentally opened.

FEMORAL HERNIA

Surgical Anatomy—This hernia occurs in the gutter between the medial margin of the psoas and the pectineus muscle It emerges by passing beneath the inner part of the inguinal ligament (Fig 279) The sac traverses the femoral canal and therefore has the following relations. On its medial aspect is the lateral border of the pubic spine and ilio-pectineal line to which is attached the lacunar (Gimbernat s) ligament the edge of which is directed upwards and outwards being obliquely situated rather like a semilunar valve Lateral to the sac is the soft but large femoral vein lying within the vascular sheath In its passage the sac lies upon the pectineus fascia and eventually meets the septum crurale (fascia propria of Cooper) In spite of statements to the contrary it does not customarily emerge through the cribriform fascia but turns laterally between the superficial layer of the deep fascia and the tendon of adductor longus, thereby coming to lie superficially to the former Any increase in size therefore, tends to direct the sac upwards and outwards in the direction of the anterior superior spine (Fig 280) In the thigh the fundus is lying quite superficially and is crossed anteriorly by the superficial circumflex iliac and superficial epigastric arteries



Fig. 280
A left femoral hernia.

The neck occupies the crural ring where the space available is very

restricted consequently the neck always remains small and the danger of strangulation by the sharp unyielding edge of the lacunar ligament is ever present In this situation the neck is in intimate relationship to that branch of deep epigastric artery which anastomoses with the obturator This anastomotic vessel occasionally takes the place of the main trunk, being known as the abnormal obturator artery When present it is in some danger during operation for relief of a strangulated hernia

Femoral hernia is not so common as the inguinal but nevertheless is a frequent cause of disability It affects women more often than men and is frequently bilateral

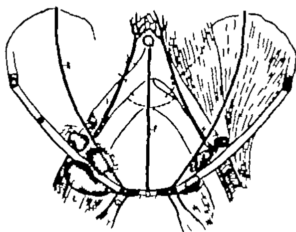


FIG. 281

The surface markings of the inguinal regions together with the areas which can be palpated in a patient.

On the right the hernial orifices are shown and on the left the directions that the hernial sacs tend to take. The dense black areas or lines are palpable.

A, anterior superior spine; B inguinal ligament; C, pubic spine; D symphysis; E, linea semilunaris; F linea alba; G adductor longus tendon; H, pectineus; J femoral artery K umbilicus; L, femoral vein.

The epigastric artery (I) arises from the femoral artery which is situated at the mid point between the symphysis pubis and the anterior superior spine. The internal ring, therefore must be lateral t this and lies at the mid point of the inguinal ligament. In the angle between the deep epigastric artery nd the linea semilunaris lies the direct hernia bove the inguinal ligament; the femoral hernia lies in the angle between the adductor longus tendon and the inguinal ligament and is, therefore below the latter

Clinical Signs.—These herniæ rarely reach a large size and usually remain quite small Patients may complain of pain and are probably aware of the presence of a swelling Owing to the narrowness of the neck and the rigidity of its walls most femoral sacs have no abdominal contents in spite of which a definite tumour can be palpated. During its passage through the femoral canal to its superficial position in the thigh the fundus pushes in front of it a quantity of extraperitoneal and superficial fat. These tissues are compressed and becoming partly fibrosed adhere to the apex of the sac in this way a tumour is produced even when the sac is empty Such herniæ therefore will be irreducible and there can be no impulse on coughing

In larger herniæ omentum and intestine enter the sac Reduction will be obtained by applying pressure first in a downward backward and inward direction and then upwards and inwards

Treatment is always operative for two reasons first the difficulty of fitting any truss with comfort and second the grave danger of strangulation

DIFFERENTIAL DIAGNOSIS OF INGUINAL AND FEMORAL HERNIÆ

The commonest clinical fault is a failure to distinguish between these two herniæ This mistake should not be made if the patients are examined properly The method may be summarised thus —

First define the anterior superior iliac spine and the pubic spine then palpate in its whole length the inguinal ligament remembering that it is convex downwards Keeping the fingers of one hand in firm contact with it define its exact relationship to the NECK of the sac. Disregard the fundus and concentrate all your attention upon the neck and the inguinal ligament (Fig 281)

In inguinal hernia the neck will be above the ligament and in femoral hernia it will be below

RICHTER'S HERNIA

This special type of rupture is described here as the great majority are seen in femoral herniæ. This dangerous condition consists in the impaction of a part of the antimesenteric zone of a coil of small intestine within the narrow neck of a hernial sac (Fig 282)



FIG 282

A Richter's hernia of the small intestine in a femoral hernia. The line of constriction is well shown and it will be seen that it does not embrace the whole of the gut-wall.

The effect upon the trapped area of intestinal wall is identical with the condition obtaining in a strangulated coil, except that only a small part of the gut wall will become gangrenous It will be understood that no symptoms will occur until impaction has taken place and that every Richter's hernia therefore is strangulated.

Clinical Signs—As the lumen of the bowel is not wholly involved a full picture of acute intestinal obstruction is not always seen. Vomiting is sometimes profuse and diarrhœa is not uncommon pain however is persistent and accompanied by attacks of severe intestinal colic The small size of the sac and its occurrence in fat patients may make the diagnosis difficult

Treatment is immediate operation.

INCISIONAL HERNIA

The causes of incisional hernia are (*a*) misplaced incision (*b*) insecure suturing (*c*) destruction of nerve supply to abdominal muscles, (*d*) hæmatoma formation (*e*) sepsis and (*f*) ill-chosen size and location of and prolonged retention of drainage tubes (Fig 283) Increase in intra-abdominal pressure due to cough intestinal distension or a combination of these must throw a great strain upon any incision. A drainage tube necessarily tends to increase the risk of herniation further the less valvular in form the incision is the more likely is hernia formation

In fat patients accurate apposition of fascia to fascia without the interposition of fatty nodules is difficult and in consequence insecure union is probable The abdominal wall is roughly convex and the first strain of a bursting force will be borne by those structures at the apex of the convexity that is upon the muscle layer subjacent to the deep fascia Should the fascia give way it is usual for the muscles to slide laterally and for the peritoneum to protrude or rupture thus permitting an escape of abdominal contents Suprafascial hæmatomata therefore are unlikely to cause hernia formation unless infected and then only if infection spreads beneath the fascia Subfascial hæmatomata on the other hand predispose to cutting out of sutures and separation of the fascial edges with consequent herniation immediately an increase of intra-abdominal pressure occurs

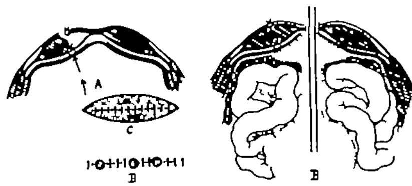


Fig 283

Incisional hernia.

A, with abdominal distension the sutures of the anterior layer of the rectus sheath may give way B, with pus in any quantity the exit is smaller than the pool, as a consequence of which an hour-glass collection is formed; the upper half consisting of pus held up beneath the anterior abdominal wall. Disruption of the sutures may occur C, Incisional hernia extending through the whole wound. D multiple or single openings in the incision due to localised [illegible]

In the presence of sepsis the proteolytic action of the pus digests tissues in the neighbourhood of the wound converting these into granulation tissue and as a result the wound is liable to stretch or burst during convalescence

When a drainage tube is inserted into a localised peritoneal abscess it passes from a dependent pool of pus to the surface via a narrow neck in the abdominal parietes. This collection of pus is soon roofed in by an adhesive mass of omentum and small intestine above which a small loculus is apt to form (Fig 283 B) This second submural pool may spread along the under surface of the incision and digest a wide area of surrounding tissues as well as those structures in the immediate vicinity of the tube itself Should this tube be too large or remain *in situ* too long the adjacent tissues are converted into a fibrous track directly the tube is removed omentum will plug the orifice and as is its custom, creep through the opening thus forming the beginning of an incisional hernia

HERNIA THROUGH THE PELVIC WALLS

Sciatic Hernia is *formed by the yielding of the fascia* covering the ciatic notch The sac follows either (1) the gluteal vessels and emerges bove the pyriformis or (2) the sciatic nerve and appears below this nuscle Whatever their course these herniæ come to lie beneath the luteus maximus muscle It is an extremely rare condition but when present usually gives rise to acute intestinal obstruction, the nature of which is discovered only at operation. It may however give rise to attacks of apparent sciatica *and in exceptional* cases may attain so great a size as to form a visible swelling in the buttock.

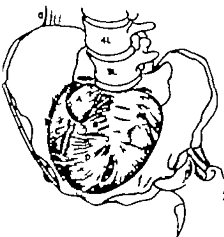


Fig. 284

The pelvic musculature and associated hernial sites. The pelvic cavity as seen from within, showing the relations of the herniæ which may occur below the pelvic brim.

The true perineal hernia passes between the two levator ani muscles. The obturator hernia is above and in front of the levator ani attachments and therefore belongs to the ventral wall; the herniæ between the obturator internus and the attachment of the levator ani and above and below the pyriformis muscle, are hernias of the lateral abdominal wall.

Notice how the sacrum forms a part of the posterior abdominal wall

A, pyriformis; B, coccygeus; C, obturator internus; D levator ani; E, ileo-pectineal line; F inguinal ligament; G quadratus; H, white line; I anus; J internal urethra.

Obturator Hernia is another rare lesion The sac emerges below and medial to the obturator vessels and nerve by passing through the inner margin of the obturator foramen. It comes to lie beneath the pectineus muscle which separates *it from the femoral artery* and vein (Fig 284) This hernia can be suspected only when there are intermittent attacks of pain referred along the course of the obturator nerve to the knee-joint. Usually it makes itself evident by a sudden attack of intestinal obstruction and its exact nature is discovered at operation

Perineal Hernia is unlikely to occur except in association with prolapse The pelvic floor is very strong it consists of the levatores ani reinforced by dense fibro-muscular tissue containing a quantity of unstriped muscle. Damage to the pelvic floor the commonest cause of which is hildbirth, usually manifests itself in the form of uterine prolapse in arying degrees of severity

A true perineal hernia has been described and is said to occur hrough the pouch of Douglas and emerge between the anus and erineal body A case is recorded in which the hernia reached as far s the knees. It should be borne in mind that in marked prolapse f the rectum in the male and of the uterus in the female a sac with potential hernia will descend in the region of the pouch of Douglas ogether with the prolapsed viscera

DIAPHRAGMATIC HERNIA

Diaphragmatic hernia is of great interest and, owing to improvement in diagnostic methods, is found to exist more frequently than was previously supposed It consists in the herniation of abdominal contents into the chest through an aperture in the left leaf of the diaphragm. It may be either congenital or acquired in origin

Congenital diaphragmatic hernia may be classified into two main groups according to the length of the œsophagus. In some cases this latter structure is congenitally short and as a result surgical inter

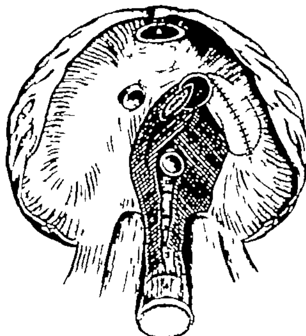


Fig 285

Hernia through the superior boundary Diaphragmatic hernia—seen from below (intra-abdominal).

A, retrosternal. B, para-œsophageal.

ference is rendered extremely difficult whereas in others the œsophagus is of normal length and operative treatment is likely to be successful

The congenital herniæ are of five main types (1) that due to absence of both crura giving rise to the condition called diaphragma transversa the organs passing into the posterior mediastinum (2) that in which the left crus only is missing the costovertebral hernia (3) that situated at the œsophageal opening which is congenitally widened so that a potential sac lies anterolateral to it the para œsophageal hernia this condition is commonly associated with a short œsophagus (4) that occurring at the junction of superior and anterior abdominal walls the retrosternal type and (5) that due to absence of the left tendon of the diaphragm and described as a hernia through the left dome (Fig 285)

CHAPTER XXVIII

THE STOMACH AND DUODENUM

ANATOMY —The Stomach lies in the upper and left part of the abdominal cavity below the liver and diaphragm It is completely invested with peritoneum being slung at its upper margin by the gastrohepatic omentum to the liver Its lower surface has attached to it the great omentum and so to all intents is free Its proximal end is firmly fixed by its continuity with the œsophagus, and its distal end is within 2½ to 3 in. of the fixed second part of the duodenum. It is apparent, therefore, that the stomach possesses a wide range of movement In life the shape and position vary greatly according to posture respiration, stage of digestion and distension or disease of neighbouring viscera. The shape as pictured in textbooks of anatomy is that of the dead stomach, but X rays have demonstrated the changes which occur during digestion. The stomach has an anterior and a posterior surface an upper and a lower border or curvature, an expanded left-hand extremity called the fundus and a narrow tubular right end where it joins the duodenum viz. the pylorus.

The anterior surface is in relation to the under surface of the left lobe of the liver the left half of the diaphragm and the anterior abdominal wall The posterior surface forms the anterior wall of the lesser sac of the peritoneum and through it is in relation with the diaphragm, the spleen the pancreas the left suprarenal capsule the upper pole of the left kidney and the transverse colon and mesocolon The superior border or lesser curvature extends in a gradual curve from the right-hand margin of the œsophagus to reach the duodenum Along its length is the attachment of the gastrohepatic omentum, by which it is slung in the upper abdomen. In its folds runs the coronary artery a branch of the coeliac axis, which reaches the œsophageal opening in the diaphragm and then turns down along the lesser curvature, sometimes as one vessel and at other times as two parallel branches, and anastomoses with the gastric branch of the hepatic artery Towards the pylorus there is a notch in the lesser curvature named the incisura angularis, which marks the division of the body of the stomach from the pyloric antrum The greater curvature arises from the left-hand end of the œsophagus, arches upwards and to the left to keep contact with the left dome of the diaphragm and so forms the great cul-de-sac of the stomach named the fundus It then runs downwards, forwards and to the right and finally curves upwards again to reach the pylorus. It is the free border of the stomach and takes part in the greatest excursions of movement in distension of the organ. It has attached to its fundal part the gastrosplenic omentum, and to the remainder the great or gastrocolic omentum, in which run the right and left gastro-epiploic vessels. The œsophagus opens into the stomach by the cardiac orifice, which lies at the upper end of the lesser curvature and well behind and below the upper limit of the fundus. The pyloric opening leads to the duodenum is guarded by the pyloric sphincter and is marked on its peritoneal surface by the pyloric vein The incisura angularis marks the point at which the stomach is arbitrarily divided into cardiac and pyloric portions The former includes

the fundus and body of the stomach while the latter is the small narrow and cylindrical end proximal to the sphincter

The blood supply is from the cœliac axis artery The coronary artery and the gastric branch of the hepatic supply the lesser curvature The right gastro-epiploic is a branch of the gastroduodenal artery which comes from the hepatic while the left gastro-epiploic is a branch of the splenic artery These two arteries traverse the greater curvature and supply both the stomach and great omentum The fundus is supplied by the vasa brevia branches of the splenic artery The veins follow their respective arteries and all end in the portal vein.

The lymph drainage is best described by dividing the stomach into three areas by prolonging the left margin of the œsophagus downwards to meet the greater curvature (Fig 287) This gives a fundal area and a main gastric area which is again divided into an upper and a lower zone by drawing a line parallel to the greater curvature in such a way that the cardiac area is divided into an upper two-thirds and a lower one-third and the pyloric area into equal upper and lower zones The fundal area is drained by vessels going to the glands in the hilum of the spleen The vessels of the upper cardiac zone drain direct into the main glands around the cœliac axis artery while those of the lower zone run at right angles to the greater curvature where they enter main trunks running in the omental attachment to end in the glands in the subpyloric region and along the pyloric end of the greater curvature The efferents of all these glands end in the cœliac group

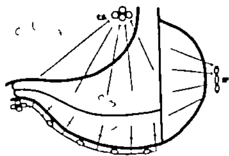


FIG 287

Diagram sho ing the lymphatic drainage of the stomach.

C.G., the cœliac gland ; SP G glands in the hilum of the spleen ; S.P G subpyloric glands.

The nerves are the right and left vagus and sympathetic branches from the solar plexus. The left vagus supplies the anterior surface and the right the posterior

The Duodenum is the first and most fixed part of the small intestine, stretching from the pylorus to the duodenojejunal junction at the left side of the body of the second lumbar vertebra. It is C-shaped and into its concavity which opens to the left is fitted the head of the pancreas

The first part is 2 in. long, and is invested completely with peritoneum in its first inch and on its anterior surface only in its second inch. In front is the under surface of the right lobe of the liver above the attachment of the lesser omentum, and behind a small recess of the lesser sac the common bile duct the portal vein and the gastroduodenal artery To its right is the gall bladder in contact with which it turns downwards to become the second part

The second part is 4 in. long and stretches from the gall bladder to the right side of the third lumbar vertebra. Behind, it is in contact with the hilum of the right kidney and the right renal vein the commencement of the right ureter and the termination of the common bile duct Anteriorly it is crossed by the attachment of the transverse mesocolon, and so lies partly above and partly below the colic shelf. On its inner aspect it has the head of the pancreas.

The third part is 3½ in long and passes horizontally across the midline

to reach the left side of the 3rd lumbar vertebra It passes in front of the right ureter the inferior vena cava and the aorta. Its anterior surface is covered with peritoneum and is crossed by the root of the mesentery and by the superior mesenteric artery and vein.

The fourth part is 1¼ in long and runs upwards to the side of the 2nd lumbar vertebra where it turns abruptly forwards to become the duodenojejunal flexure

The blood supply is from the superior pancreaticoduodenal branch of the gastroduodenal artery and from the inferior pancreaticoduodenal branch of the superior mesenteric artery The veins pass to the portal vein, and the lymphatics drain into the pyloric and pancreaticoduodenal glands, the efferents of which end either in the coeliac or superior mesenteric group of juxta-aortic glands.



FIG. 288

An X-ray of a barium meal showing a lesser curvature ulcer

Four duodenal fossæ of the peritoneum are described as existing around the duodenojejunal flexure and are said to be one of the causes of internal herniæ They are named superior inferior paraduodenal and retroduodenal fossæ

METHODS OF EXAMINATION

A **Clinical.**—An exact case history will be sufficient to allow a correct diagnosis in many cases of gastroduodenal disease and in few parts of the body is care and skill in this direction so profitable A physical examination of the abdomen yields little information, unless areas of tenderness or a tumour be present

B **Test Meals.**—The fractional test meal is done with an Einhorn's tube the gastric contents are removed a meal of oatmeal gruel given, and then 15 c c. withdrawn every quarter of an hour In this way a determination can be made of the amounts of mineral chlorides, total acidity and free hydrochloric acid, and of the presence of starch sugar blood pus or bile

For diagnostic purposes test meals are far less reliable than barium meal radiography but in early cases of malignant disease for example the combination of the two methods may be of service

C **Barium Meal Radiography**—In the hands of a skilled radiologist the examination of the stomach and duodenum by the barium meal technique will yield over 90 per cent of correct diagnoses Screening will always give more information than photographs and it should be understood that the exposure of a series of films does not constitute an efficient radiographic examination The various findings will be described under the appropriate disease (Fig 288)

D **Gastroscopy** has passed the experimental stage and Hermon aylor's flexible gastroscope marks a great advance Although this ethod of examination must always have a limited field of usefulness is likely to lead to an earlier diagnosis of carcinoma than is possible y other means

CONGENITAL ANOMALIES

These are very rare consisting of stenosis in the body of the stomach t the pylorus, or in the duodenum at the ampulla of Vater The omach may be misplaced *e.g* in the thorax in a congenital diaphrag natic hernia These conditions are pathological curiosities only

INJURIES

Injuries of the stomach and duodenum are not common and may e classified as (1) contusions (2) rupture which is spontaneous or raumatic and (3) penetrating wounds.

Contusions of the Stomach are produced by crushing or run over ccidents in which no grave symptoms are present but there is pigastric pain and vomiting of blood or blood-stained mucus Pro-ided no other injury coexists a short rest is sufficient treatment

Rupture of the Stomach.—The spontaneous variety which is very are follows over-distension with food acute dilatation or severe omiting The rupture is high up on the lesser curvature near the esophagus and the result is fatal. Traumatic rupture is rare because he stomach is so well guarded by the costal margin and its injury rithout any accompanying abdominal lesion is rarer still It may esult from a violent blow in the epigastrium from crushes run over' ccidents the careless passage of oesophageal bougies or from over listension with air gas or fluid during lavage Cases are reported of intratracheal catheters being passed into the oesophagus by mistake and then attached to a mechanical anaesthetic apparatus with resultant rupture of the stomach The area affected is usually he anterior surface near the greater curvature and if the accident occurs when the stomach is full, peritoneal soiling may be extensive

Penetrating Wounds of the Stomach are caused by stabs from sharp nstruments knives daggers, bayonets etc or by rifle bullets or hell splinters A few cases are recorded of perforation from within n people who swallow swords In the majority of cases other organs are injured as well.

Symptoms and Signs—These will depend on the size of the tear the degree of gastric distension, the amount of food contained at the time and the co-existence of other visceral injury In all cases some leakage into the peritoneum will occur with some bleeding into the tomach Peritonitis of varying severity and extent and hæmatemesis are to be expected In some cases so fine a perforation has occurred in an empty stomach that the rent has been closed by omental adhesions or a small localised perigastric abscess may have formed but usually the condition is more serious At first there is a stage of acute onset with marked shock an initial attack of vomiting increasing abdominal

pain and later the vomiting becomes re-established and severe The vomit usually contains blood and this will be the only symptom pointing directly to the stomach The condition may be complicated by rupture of other hollow viscera or of a solid viscus resulting in intraperitoneal bleeding Indeed, no typical picture can be given as the factors producing the clinical condition vary so widely

Treatment—Every wound which penetrates the abdominal wall MUST be explored no matter how trivial the symptoms appear and in *all crushes* and run over accidents a *doubtful diagnosis should* be synonymous with an exploratory laparotomy The wound in the stomach is sutured in two layers with catgut, and the operator then turns his attention to the elimination of any other injury After the usual peritoneal toilet the abdominal incision is closed with or without drainage as each individual case demands

Rupture of the Duodenum is rare except at the duodenojejunal *flexure where injuries are not uncommon* These are described under Rupture of Hollow Viscera (p 546) When rupture of the duodenum does occur it may be partial or complete intraperitoneal or retroperitoneal It may be damaged in penetrating wounds in conjunction with other visceral organs. The symptoms and treatment follow the lines of those of gastric injuries.

FOREIGN BODIES IN THE STOMACH AND DUODENUM

The swallowing of foreign bodies is largely confined to children, hysterical young women and insane adults At one stage in their early life children are always putting things in their mouth and they may swallow a variety of small toys, beads and nuts and bolts from their cots or pens. The hysterical girl is the type that eats her own hair and produces the hair ball Insane adults swallow the most surprising *miscellany of objects, many of which are too large to be ingested* with equanimity by the sane *e.g* forks knives and spoons. The author has operated on one female lunatic on three occasions to remove a full-sized dinner fork from her stomach and on four occasions on another who swallows large sewing needles in pairs on a single loop of thread.

Hair Balls are produced by hair collecting in the stomach, where being formed into a firm mass it may become moulded to the shape of the organ with a projection upwards into the œsophagus and another forward into the pylorus They are seen in neurotic women who nibble at the ends of their own hair There is a specimen in the St Mary's Hospital Museum of two hair balls removed by Clayton Greene in 191? A recent communication in the *Lancet* reported that this same patient had been operated on for the seventh time for hair balls (Fig 289)

Symptoms depend on the type of foreign body present A great many *will pass through the pylorus, after which they* will probably succeed in traversing the length of the intestinal tract and be passed per rectum. In those that fail to pass the pylorus, slight epigastric pain and nausea may be the first sign that anything is amiss unless the fact that a foreign body has been swallowed is known. In these

cases no symptoms occur for several days until ulceration of the mucous membrane occurs

Treatment—If the patient is seen shortly after the swallowing a radiograph is taken. If the size and shape make it certain that there is no hope of the foreign body passing an operation is performed as soon as possible but if the contours suggest that it will pass the pylorus soft milky foods *e.g* porridge bread and milk, should be given and a second film taken in twenty four hours In those cases in which no progress is made not more than seven days should be allowed to elapse before the foreign body is extracted and the stomach sewn up with a double row of sutures Hair balls will remain unsuspected for many months or years, until a mild dyspepsia calls attention to the abdomen.



FIG. 286
Two hair balls removed from the stomach of a female patient.

Foreign bodies in the duodenum are very rarely seen clinically as those which succeed in passing the pylorus are not likely to get held up in the duodenum Long needles however may fail to negotiate the curve of the duodenum and penetrate its walls In children Kirby Grips find passage equally difficult

GASTRIC AND DUODENAL FISTULÆ

These fistulæ may be either external in which the opening is on to the skin of the abdomen or internal when the communication is with another hollow viscus. Modern methods of diagnosis and treatment have made these conditions extremely rare

External Gastric Fistulæ are now seen only as pathological curiosities, except those formed deliberately (*e.g* gastrostomy) in cases of œsophageal obstruction The most famous example is that of Alexis St Martin, whose fistula resulted from a bullet wound. An untreated carcinoma of the stomach might invade and break through the abdominal wall

Internal Gastric Fistulæ may follow injury but are usually due to disease The communication is with the duodenum jejunum colon or gall bladder and the disease may be primarily in the stomach *or* in these other viscera. Ulcer and carcinoma of the stomach may invade the intestine carcinoma of the colon may erode the stomach and chronic ulcerative cholecystitis with gall-stones may lead to a

communication being formed between the gall bladder and the py
end of the stomach The symptoms of a gastrocolic fistula are persi
diarrhœa occurring shortly after a meal the stools containing undig
food and less commonly the vomiting of fæcal material These w
superimposed on the symptoms of the causative disease The diag
will rarely be in doubt A fistula between the gall bladder and
stomach may lead to the vomiting of a calculus The treatme
directed towards the cause, and may entail resections of a portic
both the stomach and the colon The operation of gastro-enterost
provides the classic example of a deliberately produced internal ga
fistula.

External Duodenal Fistulæ occasionally follow injury particu
operative procedures Operations on the biliary system (*e.g.*, t
duodenal or retroduodenal choledochotomy) will rarely be followe
a fistula but those on the right kidney provide the majority
second part of the duodenum lies over the right renal hilum an
vessels, and is peculiarly liable to injury by careless manipulatio
in the application of clamps to the renal pedicle particularly if se
bleeding is occurring at the time Fistula may follow a renal opera
after an interval as a result of sepsis in the renal space without effic
drainage An abscess may form and erode the duodenum and if
wound reopens then a duodenal fistula will result Many of t
fistulæ will heal spontaneously after a time but if they fail to do
an operation for their closure must be attempted, although it
prove a hazardous undertaking

Internal Duodenal Fistulæ occur only with the gall bladder a
result of chronic ulcerative cholecystitis with gall-stones these la
will eventually be passed into the duodenum and be evacuated
rectum provided they are not sufficiently large to become impa
in the lower part of the ileum. The symptoms are those of
causative condition, and modern methods should render this typ
fistula a matter of historical interest only After the stone has pas
the symptoms will probably subside and it may be considered s
to leave the patient without attempting any operation.

THE STOMACH

INFANTILE HYPERTROPHIC STENOSIS OF THE PYLORUS

Etiology—This condition occurs in infants during the first six we
of life being more common in first born males who are usually bre
fed and among the more prosperous members of the communi
The cause is imperfectly understood and it is possible that there a
two types one in which there is a true overgrowth of the pylo
muscle, and another in which the symptoms are produced by spa
only It is suggested that the change in the pylorus may be due t
(1) incorrect feeding leading to pyloric spasm, which eventua
produces an actual hypertrophy (2) hyperadrenalism both int
uterine and after birth (3) mass reflex action initiated by phimos
or (4) some defect in the neuromuscular control of the sphincter

Pathology.—The sphincter muscle is greatly hypertrophied without any fibrosis, as a result of which the pylorus is converted into an enlarged firm cylinder about 1 in in diameter and glistening white in colour The muscular hypertrophy stops abruptly at the pyloro duodenal junction but extends proximally into the stomach walls for a varying extent The mucous membrane is thrown into folds and thus further obstructs the lumen. The stomach is dilated and hyper trophied but the duodenum is normal and into it the thickened pylorus projects with a groove around it in a manner suggestive of the cervix uteri in the vagina (Fig 290)

Symptoms and Signs.—The first symptoms appear at any time between the second and sixth week Until then the baby has been healthy with no unusual features in connection with appetite feeding weight and general condition, except that it may have been given feeds excessive in amount The symptoms are vomiting wasting and constipation The vomiting rapidly becomes persistent and is projectile in type the vomit containing neither bile nor blood The loss of weight is very rapid and constipation is absolute An examination of the abdomen will reveal visible peri stalsis perhaps a localised epigastric distension and a palpable tumour

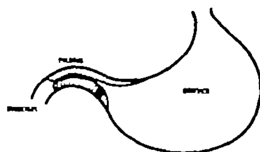


FIG 290

A diagrammatic sketch of infantile pyloric stenosis.

Treatment.—A trial should always be given at the outset to gastric lavage and careful feeding In such patients an antispasmodic—eumydrin—may also be used with advantage It is said that cases which recover with such treatment are spasmodic and not true hyper trophy Nevertheless many babies with typical symptoms have been saved in this way Small feeds given often at regular intervals are combined with careful lavage before each feed, which is introduced through the catheter before its withdrawal. If this fails to arrest the vomiting and if the child continues to lose weight no time should be lost in advising operation The important point is that the decision to operate should not be left until the infant is too emaciated to survive the laparotomy

The Rammstedt Operation is the only one practised to-day It should be done under local anæsthesia and consists in dividing the thickened pylorus along its anterosuperior surface down to the mucous membrane which will pout through the wound Care must be taken to divide the fibres in the part which projects into the duodenum and to avoid injuring the mucosa of the duodenum or stomach The final separation of the muscle fibres should be by blunt dissection with the handle of the scalpel. No attempt is made to cover in the pouting mucosa and the abdomen is closed Gentleness and speed are highly important and the mortality will depend on the surgeon's skill the

state of the child before operation and meticulous attention to post-operative feeding and nursing

ACUTE DILATATION OF THE STOMACH

Etiology—This is a definite clinical entity and its importance must be appreciated by every practitioner It may occur as a fatal ending to chronic dilatation or other gastric disease but is of the gravest significance as a post-operative complication because it is rapidly fatal if not recognised. Of the many theories brought forward to account for it only two are worthy of consideration First after operation the intestines sag down into the pelvis and drag on the mesentery and as a result the superior mesenteric vessels are drawn tight over the third part of the duodenum and constrict it against the vertebral bodies second, the condition is a paralytic one comparable to paralytic ileus and is possibly due to pulling on the sympathetic plexuses around the cœliac axis artery The operations concerned are usually those on the stomach, gall bladder spleen, pancreas or kidney but it may occur after almost any operation under general anæsthesia.

Pathology—The stomach is enormously dilated, filling the whole abdomen The distension never stops at the pylorus but in many cases ends abruptly at the point where the superior mesenteric vessels cross the duodenum while in others the upper part of the jejunum will participate

Symptoms—These are vomiting and abdominal distension. The ordinary post-anæsthetic vomiting having subsided within the first twenty four hours, any further attack should be regarded with suspicion It may be indicative of several complications all of which are serious. In acute dilatation large quantities of greenish watery fluid are repeatedly vomited, the amount of the fluid being one of the most striking features The distension is definite from the beginning and later becomes enormous. There is one feature of paramount importance in this distension in that of the intestine either colic or enteric the epigastric triangle bounded by the costal margins and the transverse colon is never seriously encroached upon. In gastric dilatation it is in this triangle that the distension first appears and always remains most obvious, the transition from the flat chest wall to the distended abdomen being markedly abrupt The patient's general condition rapidly deteriorates from dehydration due to the profuse vomits The pulse becomes thin thready and rapid and collapse soon sets in death occurring within twenty four hours In some cases the dilatation is subacute and the vomiting less frequent and less profuse the distension less marked and the general condition better maintained, but they will pass into the acute type unless treated.

Treatment consists in gastric lavage the prone position and intra venous infusions In the early stages if the slightest doubt exists a Ryle's tube is passed into the stomach preferably through the nose The contents are completely removed by suction and warm sodium bicarbonate solution is run in This process of siphonage and washing is continued until the washings are clear The tube is left *in situ* and the stomach emptied every half hour

Should the case be left undiagnosed until large vomits are occurring a large stomach tube must be passed as rapidly as possible An attempt to swallow a small tube has been known to lead to aspiration of the vomitus into the trachea death resulting The stomach is emptied and washed as before and the tube removed. The patient is then placed flat on his face and the foot of the bed raised on blocks. If another attack of vomiting occurs this procedure is repeated Success depends upon early diagnosis and prompt lavage Secondary operations such as gastrostomy and gastrojejunostomy are useless

CHRONIC DILATATION OF THE STOMACH

This is not a clinical entity but merely a symptom of gastric and other disease and comes under two headings viz. obstructive and atonic The obstructive type can be further subdivided into intrinsic and extrinsic

1 Intrinsic
- (a) Chronic ulcer of stomach and duodenum
- (b) Pyloric stenosis infantile and acquired.
- (c) Gastric polypus blocking the pylorus.
- (d) Fibrous stricture of the pylorus
- (e) Gastroptosis
- (f) Chronic duodenal ileus
- (g) Malignant disease of the stomach

2. Extrinsic
- (a) Malignant disease of liver gall bladder pancreas colon and kidney
- (b) Perigastric adhesions.
- (c) Mobile right kidney
- (d) Pancreatic cysts
- (e) Aneurysms.

The clinical features are considered under the sections dealing with the disease in question.

GASTRIC TETANY

Tetany is due to parathyroid deficiency but it does occur in other conditions one of which is pyloric obstruction. Occasionally in these cases the typical spasms will be seen affecting chiefly the upper extremities. The hand goes into the position of *main d'accoucheur* and muscular twitchings occur all over the body The stomach should be washed out and the cause of the pyloric stenosis dealt with

THE INFLAMMATORY DISEASES OF THE STOMACH

These may be classified as follows —

Acute gastritis
- Catarrhal.
- Phlegmonous
- Suppurative

Chronic gastritis
Linitis plastica or fibromatosis of the stomach.
Tuberculous and syphilitic disease

Acute and chronic gastritis are described in textbooks of medicine

and tuberculous and syphilitic disease are so rare that no description of them is needed here.

Linitis Plastica or Fibromatosis of the Stomach.—This rare condition, also called leather bottle stomach, consists of a widespread fibrosis in the submucous coat of the stomach which may be wholly or partly affected As a result the walls may be an inch or more in thickness the cavity diminished and elasticity lost Undoubtedly most cases are due to carcinoma but there are some in which no growth can be found and which are due to infection from a chronic ulcer or to a toxic condition not identified The disease is insidious in onset with vague epigastric discomfort and vomiting A palpable tumour is to be felt and a diagnosis should be made by X ray

Treatment is gastrectomy

CARCINOMA OF THE STOMACH

Etiology—Carcinoma of the stomach is the commonest of all cancers in men, accounting for about 22 5 per cent of the total, and is the third commonest in women being exceeded only by those of the uterus and breast It affects men slightly more frequently than women occurring between the ages of 35 and 70 years although cases are on record before 20 Its causation is unknown but its relationship to chronic gastric ulcer is discussed on p 629

Pathology—Naked-eye appearance Four types are seen

1 The submucous scirrhus type
2 The fungating cauliflower growth
3 The ulcer which is either (*a*) the ulcerating carcinoma or (*b*) the ulcer-carcinoma
4 Leather bottle stomach.

The Submucous Growth is seen either at the pylorus or on the lesser curvature as a thick ivory white mass in and beneath the mucous membrane At the pylorus it will spread round the canal and obstruct the orifice It may cause the pylorus to project into the duodenum, but the infiltration stops short at that point and never affects the duodenal wall. From the main mass the growth spreads along the submucous plane gradually becoming thinner until it can no longer be distinguished. Superficially it is ulcerated and infected. In this group the amount of fibrosis varies some cases causing pyloric obstruction with little tumour formation, while others give rise to a large cellular growth

The Fungating Cauliflower Growth appears as a large soft growth projecting into the lumen of the stomach and infiltrating the stomach wall to a comparatively small extent (Fig 291) It may grow to a very large size before giving symptoms It is seen usually in the body of the stomach

The Ulcerating Carcinoma consists of an excavating ulcer with hard everted edges infiltrating the muscle and peritoneum (Fig 293) The carcinoma arising in a chronic ulcer has the usual appearance of that ulcer and the growth arises at one side usually towards the pylorus

The Leather bottle Stomach, when due to carcinoma is widely and diffusely infiltrated with a scirrhous type of growth which spreads throughout the organ in the submucous layer The stomach becomes contracted and very thickened



FIG 291

A large fungating growth of the stomach

Microscopic Detail —These growths are either an adenocarcinoma of the columnar-celled type or a carcinoma simplex. The adenocarcinomata mimic very closely the normal gastric mucosa The amount of fibrosis varies considerably some being rapidly growing cellular tumours and others densely scirrhous Some undergo mucoid degeneration and are known as colloid carcinomata Œsophageal growths may spread into the cardiac end of the stomach and are squamous-celled tumours

Methods of Spread—Local infiltration occurs in the submucous, muscular and peritoneal coats When the peritoneum is invaded adhesions form and along these adhesions tumour cells spread to neighbouring viscera *e g* pancreas liver spleen and colon. Lymphatic embolism and permeation lead to involvement of the cœliac and subpyloric glands and later of those in the portal fissure In rare cases the growth spreads up along the thoracic duct and an enlarged gland appears in the left supraclavicular triangle Venous embolism leads to deposits in the liver The growth is apt to spread diffusely on the peritoneum and structures in the pelvis may be involved by little fragments of growth dropping off the stomach and becoming engrafted bilateral Kruckenberg tumours of the ovaries are the most notable examples of this process. It is worthy of special notice that infiltration always stops short of the duodenum



FIG. 292

An ulcerating carcinoma of the stomach.

Symptoms —It is impossible to present a composite picture of the clinical findings in carcinoma of the stomach because patients arrive for advice with such a variety of symptoms The picture will depend

upon the type of growth and its position in the stomach. In the later stages all the symptoms may be present but at least in the early stages it is convenient to classify patients into certain groups These must not be considered as complete entities but as affording an indication of the manner in which these patients first seek advice

Group I—The Dyspeptic Group.—The onset is vague and indefinite in a patient of 40 years and over who has previously been free of indigestion. At first some epigastric discomfort is combined with a failing appetite and after some time the discomfort will become real pain, which tends to show no typical time relation to food and further is not relieved by food. Later anæmia and wasting become marked features A palpable tumour is of very late appearance In those cases in which the carcinoma has resulted from a chronic ulcer the typical ulcer history will have been present for a long time

Group II—The General Malaise Group consists of those patients who come first for advice complaining of loss of weight loss of energy and being so easily tired. They may deny any indigestion or dismiss it as trivial but they will probably admit that their appetite is not as good as it had previously been. They will be found to be anæmic

Group III—The Pyloric Stenosis Group is well illustrated by a case of the author's a lady of 60 years in perfect health who went to stay with friends in the country One afternoon, without warning she felt sick and a copious vomit resulted This was repeated at regular intervals for a few days when a barium meal revealed a pyloric stenosis.

Group IV—The Silent Group comprises a few cases who seek advice for other conditions and in whom there is nothing to point to the stomach, the growth being discovered in a routine examination.

Group V—The Rare Group in which the symptoms are those of œsophageal obstruction, the growth being immediately in the region of the cardiac orifice

Other special symptoms usually late in occurrence are bleeding ascites and jaundice Bleeding may be profuse but is rarely so it may be a slow leak which shows in the vomit as darkish material designated the coffee ground vomit but usually it can be recognised only as occult blood in the stools Ascites and jaundice are evidence of liver and peritoneal involvement

In general the picture is characterised by the vague and indefinite onset and some patients continue to have an indeterminate story until the growth is inoperable It must be appreciated that a palpable tumour usually means an inoperable growth. The lesson to be learnt is that every patient of 40 years and over who begins to complain of vague indigestion loss of appetite and of energy and who has a mild degree of secondary anæmia is in need of a thorough investigation It is at this stage that a carcinoma is not only operable but curable The following findings may emerge from a routine overhaul (*a*) a test meal may reveal diminution or absence of hydrochloric acid (*b*) occult blood occurs in the stools (*c*) blood and fragments of growth in the vomit (*d*) a blood count reveals a well marked secondary anæmia (*e*) a barium meal radiograph shows a filling defect poor motility and delayed emptying time and (*f*) gastroscopy permits

actual visualisation of the growth Of these the X ray examination is of the greatest importance but increased experience of gastroscopy will lead to an earlier diagnosis than is possible at present

Prognosis —These growths do not necessarily progress quickly but their indefiniteness makes diagnosis difficult Early diagnosis gives a high proportion of cures The growths at the pylorus have yielded best results in the past but the advent of transpleural gastrectomy may lead to a great improvement in prognosis of growths at the cardiac end

Treatment —Growths of the pyloric region can be completely

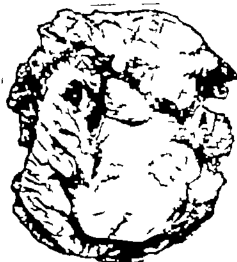


FIG. 293
Sarcoma of stomach.

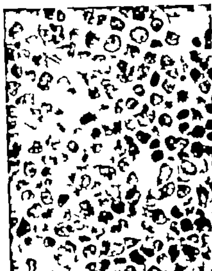


FIG. 294
Microscopic section showing round-celled sarcoma.

removed by a partial gastrectomy of the Polya Balfour type Growths of the body and fundus are sometimes amenable to transthoracic gastrectomy but those involving the œsophageal opening often prove inoperable Growths obstructing the pylorus which are inoperable will benefit temporarily from a gastro-enterostomy

OTHER GROWTHS OF THE STOMACH are very rare Round-celled sarcoma is seen in young people (Figs 293 and 294) myosarcoma and lymphosarcoma in the middle aged and examples of adenomata fibromata, submucous lipomata and myomata are reported

PEPTIC ULCERS

Peptic ulceration is defined as ulceration of any part of the gastro intestinal tract the mucous membrane of which is in contact with gastric secretions Under this heading therefore will be described

1 *The etiology and pathology of peptic ulceration in general*
2 Gastric ulcers and their complications
3 Duodenal ulcers and their complications
4 *Gastrojejunal or anastomotic ulcers*
5 Jejunal ulcers

ETIOLOGY OF PEPTIC ULCERATION

In spite of a vast amount of research the causation of peptic ulcers remains an unsolved problem Certain facts are known, and some clinical and pathological observations yield suggestions of contributory factors The known facts include

(a) Ulcers occur in those parts of the gastro-intestinal canal bathed in gastric juice i.e. the stomach, the first part of the duodenum and the jejunum after gastrojejunostomy

(b) The chronic progressive ulcer occurs chiefly in that part of the stomach known as the gastric canal or pathway and in the duodenum. After gastrojejunostomy the anastomosis and part of the jejunum near at hand become physiologically part of the gastric pathway (see under Pathology p 621)

(c) Typical ulcers have been produced in the small intestine by diverting the bile and pancreatic juices to a lower segment of the intestine (Mayo Clinic)

(d) Normal gastric and duodenal mucous membrane is proof against autodigestion (i.e by their own secretions)

(e) *Peptic ulcers are due to autodigestion of localised areas which* have lost their normal protection.

(f) Hyperchlorhydria alone is unable to cause ulcer for many cases of known acid excess remain ulcer free while only 23 per cent. of ulcer cases have hyperchlorhydria It does however undoubtedly retard healing

(g) The hypertonic stomach is one which empties too rapidly and produces its secretions in excess This type is known to predispose to *duodenal ulcer and as it is common in men, this may explain the* greater incidence of duodenal ulcer in men.

The factors which may be contributory are

(h) Focal sepsis in the teeth tonsils nasal sinuses appendix or gall bladder may all coexist with ulcer Rosenow's experimental work suggests an etiological relationship between ulcer and infection.

(i) Alcohol in all forms and cigarette smoking particularly of the cheap Virginian brands may have some causative significance They *undoubtedly delay healing*

(j) Pyloric spasm or stenosis is also suggested as contributory

(k) Blocking of the arterioles of the stomach wall has been produced experimentally and ulcers have resulted This provides a most attractive theory that an embolus may block a vessel and cause devitalisation of an area of gastric mucosa which loses its protection and becomes digested. But these ulcers are all acute and heal very rapidly and all attempts to prevent their healing fail

(l) A psychological background is present in many cases especially duodenal and the association of worry and overwork is a potent factor in etiology

It is evident that the determining factor must be the cause of the local devitalisation of mucous membrane which allows autodigestion to occur It is this problem which has defied solution Many causes [illegible] suggested *e.g* sepsis thrombosis and embolism of the gastric

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THE PATHOLOGY OF PEPTIC ULCERATION

Three types are described

1 The acute erosion
2 The acute ulcer and
3 The chronic progressive or indurated ulcer

1 **The Acute Erosion** is found in any part of the stomach may be multiple or single and is so small that it is hardly recognisable in life even when the stomach is widely opened. At post mortem the stomach wall may have to be held up to a strong light before the erosion is seen. When visible it appears as a small area in which there is digestion of mucous membrane but muscle is not attacked There is complete absence of any swelling œdema or induration around it

2 **The Acute Ulcer** also occurs in any part of the stomach and may be single or multiple It rarely exceeds half an inch in diameter is oval in shape and has a cleanly punched-out edge The muscle coat is invariably affected in those specimens seen after death or operative removal There is a slight hæmorrhagic effusion into the mucous membrane surrounding the ulcer with some œdema but no induration It is said that acute ulcers perforate but this is uncommon in such cases the ulcer cavity is funnel-shaped with a broad base on the mucosal surface and a small perforation through the peritoneum As most specimens are post mortem ones it is not easy to give an account of their living pathology They heal readily with little or no scarring Erosions and acute ulcers are more commonly diagnosed in women but there are grounds for the belief that a large number of people have small acute ulcers which form and heal in so short a time that they are not recognised clinically

3 **The Chronic Progressive or Indurated Ulcer** occurs chiefly in the gastric canal or pathway The musculature of the stomach is so arranged that a tube can be formed along the lesser curvature allowing fluids to pass when the stomach is empty direct from œsophagus to duodenum The fundus and cardia form a digestive chamber while the gastric canal transmits the products of digestion to the duodenum The chronic ulcer therefore is found on the lesser curvature on the gastric walls adjacent to it in the pyloric antrum and the duodenum as far down as the ampulla of Vater After a gastrojejunostomy the anastomosis and the segment of jejunum concerned come to be included in the gastric pathway

The term chronic is somewhat misleading in that it applies only to the time factor and the after-effects of the ulceration The process is not a chronic one in the sense that a tuberculous or syphilitic lesion is chronic for at each recurrence the ulceration is definitely acute

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(g) The hypertonic stomach is one which empties too rapidly and produces its secretions in excess This type is known to predispose to duodenal ulcer and as it is common in men this may explain the greater incidence of duodenal ulcer in men.

The factors which may be contributory are

(h) Focal sepsis in the teeth, tonsils nasal sinuses appendix or gall bladder may all coexist with ulcer Rosenow's experimental work suggests an etiological relationship between ulcer and infection.

(i) Alcohol in all forms and cigarette smoking particularly of the cheap Virginian brands, may have some causative significance They undoubtedly delay healing

(j) Pyloric spasm or stenosis is also suggested as contributory

(k) Blocking of the arterioles of the stomach wall has been produced experimentally and ulcers have resulted This provides a most attractive theory that an embolus may block a vessel and cause devitalisation of an area of gastric mucosa, which loses its protection and becomes digested But these ulcers are all acute and heal very rapidly and all attempts to prevent their healing fail

(l) A psychological background is present in many cases especially duodenal and the association of worry and overwork is a potent factor in etiology

It is evident that the determining factor must be the cause of the local devitalisation of mucous membrane which allows autodigestion to occur It is this problem which has defied solution. Many causes are suggested. e.g sepsis thrombosis and embolism of the gastric

vessels anæmia high blood pressure hypothalamic dysfunction or a toxin of unknown origin and finally an unidentified virus is believed to be a possible factor

THE PATHOLOGY OF PEPTIC ULCERATION

Three types are described

1 The acute erosion
2 The acute ulcer and
3 The chronic progressive or indurated ulcer

1 **The Acute Erosion** is found in any part of the stomach may be multiple or single and is so small that it is hardly recognisable in life even when the stomach is widely opened At post mortem the stomach wall may have to be held up to a strong light before the erosion is seen. When visible it appears as a small area in which there is digestion of mucous membrane but muscle is not attacked. There is complete absence of any swelling œdema or induration around it

2 **The Acute Ulcer** also occurs in any part of the stomach and may be single or multiple It rarely exceeds half an inch in diameter is oval in shape and has a cleanly punched-out edge The muscle coat is invariably affected in those specimens seen after death or operative removal There is a slight hæmorrhagic effusion into the mucous membrane surrounding the ulcer with some œdema but *no* induration. It is said that acute ulcers perforate but this is uncommon in such cases the ulcer cavity is funnel-shaped, with a broad base on the mucosal surface and a small perforation through the peritoneum. As most specimens are post mortem ones it is not easy to give an account of their living pathology They heal readily with little or no scarring Erosions and acute ulcers are more commonly diagnosed in women, but there are grounds for the belief that a large number of people have small acute ulcers which form and heal in so short a time that they are not recognised clinically

3 **The Chronic Progressive or Indurated Ulcer** occurs chiefly in the gastric canal or pathway The musculature of the stomach is so arranged that a tube can be formed along the lesser curvature allowing fluids to pass when the stomach is *empty* direct from œsophagus to duodenum The fundus and cardia form a digestive chamber while the gastric canal transmits the products of digestion to the duodenum. The chronic ulcer therefore is found on the lesser curvature on the gastric walls adjacent to it in the pyloric antrum and the duodenum as far down as the ampulla of *Vater* After a gastrojejunostomy the anastomosis and the segment of jejunum concerned come to be included in the gastric pathway

The term chronic is somewhat misleading in that it applies only to the time factor and the after-effects of the *ulceration* The process is not a chronic one in the sense that a tuberculous or syphilitic lesion is chronic for at each recurrence the ulceration is definitely acute

ETIOLOGY OF PEPTIC ULCERATION

In spite of a vast amount of research the causation of peptic ulcers remains an unsolved problem Certain facts are known and some clinical and pathological observations yield suggestions of contributory factors The known facts include

(a) Ulcers occur in those parts of the gastro-intestinal canal bathed in gastric juice i e the stomach, the first part of the duodenum and the jejunum after gastrojejunostomy

(b) The chronic progressive ulcer occurs chiefly in that part of the stomach known as the gastric canal or pathway and in the duodenum. After gastrojejunostomy the anastomosis and part of the jejunum near at hand become physiologically part of the gastric pathway (see under Pathology p 621)

(c) Typical ulcers have been produced in the small intestine by diverting the bile and pancreatic juices to a lower segment of the intestine (Mayo Clinic)

(d) Normal gastric and duodenal mucous membrane is proof against autodigestion (i.e. by their own secretions)

(e) Peptic ulcers are due to autodigestion of localised areas which have lost their normal protection

(f) Hyperchlorhydria alone is unable to cause ulcer for many cases of known acid excess remain ulcer free while only 23 per cent of ulcer cases have hyperchlorhydria It does however undoubtedly retard healing

(g) The hypertonic stomach is one which empties too rapidly and produces its secretions in excess This type is known to predispose to duodenal ulcer and as it is common in men this may explain the greater incidence of duodenal ulcer in men.

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but every attack leaves behind it a heritage of fibrosis and indura From the clinical aspect the term will suffice but it is better to l it into line with pathological truth by adopting the name ch progressive or chronic indurated, ulcer

Its appearance is typical as shown in the accompanying se (Fig 295) The ulcer is oval in shape with its long axis at right a to the lesser curvature The proximal (œsophageal) rim is overhan and undermined, and the distal (pyloric) edge is a gradual slop from the floor Almost every ulcer shows evidence of healing occur

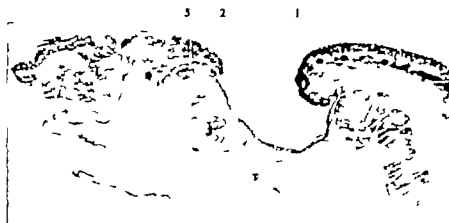


FIG 295

A low power photomicrograph of a chronic progressive peptic ulcer

1 the overhanging proximal edge 2, the sloping distal edge; 3, the muscularis muc 4 the muscle coat; and 5, the point t which muscularis mucosæ and muscle coat un

simultaneously with ulceration the former taking place along sloping distal edge and the latter progressing under the overhang proximal rim Four histological characteristics of a chronic progres ulcer are described They are

(a) Complete destruction of the muscle coat in the centre of ulcer
(b) Dense fibrosis in the base
(c) Fusion of the muscularis mucosæ with the muscular coat at margin of the ulcer and
(d) Presence of endarteritis obliterans in the vessels around

The old teaching that the chronic ulcer was terraced was bas on post mortem specimens and is occasionally seen in the early sta of an acute exacerbation of the ulceration apart from this terraci does not occur

The complications of peptic ulceration are accounted for by healing progression and induration The periods of remission symptoms correspond to the healing of the ulcer penetration p foration and hæmorrhage result from progression and stenosis a hour-glass stomach from fibrosis

THE UNCOMPLICATED GASTRIC ULCER

These ulcers are slightly more common in men than women, the chronic progressive ulcers being definitely so in the proportion of [illegible]. But the acute ulcers being more common in women, the difference nearly balances the incidence in the sexes.

Acute Erosions and Acute Ulcers are commonly seen in young women of the chlorotic type, but they attack both sexes at any age, particularly between [illegible] and 4[illegible] years. They heal so rapidly that it is probable they occur in a great number of people without being diagnosed, giving short lived attacks of epigastric disturbance popularly termed indigestion. Usually they are recognised because of hæmatemesis, which may be severe but rarely fatal. Occasionally an acute perforation may occur.

Their *treatment* is medical.

CHRONIC PROGRESSIVE GASTRIC ULCER

This is seen more commonly in men between the ages of 30 and [illegible] years, but it is not confined within these limits, *e.g.* the author has recently operated on a boy of 1[illegible] and on three men of 71, [illegible]2 and 7[illegible] respectively. The age incidence in women is somewhat earlier. They occur in the pyloric antrum, on the lesser curvature and on the posterior wall in that order of frequency.

Symptoms.—The clinical picture is so characteristic that a high proportion can be diagnosed on the history alone. It consists of periodic attacks of pain after food. The intervals between the attacks may last as long as a year, during which the patient is perfectly well and unconscious of any gastric trouble. As time goes on the intervals tend to get shorter and the attacks last longer. This periodicity is of the utmost importance in the diagnosis of peptic ulceration and is due to the healing of the ulcer in the intervals of activity. Each attack lasts about three to five weeks. During the attacks the chief symptom is pain, which in each individual patient bears a constant relation to food. It varies between half an hour to two hours after a meal and is dependent on the position of the ulcer, the nearer the ulcer is to the pylorus the longer the delay in onset. The severity of the pain varies considerably and is not constant in the same individual. It is described as being in the epigastrium on one or other side of the midline and may be referred to the back in the region of the inferior angle of either scapula. **Vomiting** is not a common symptom, but when present has the effect of relieving the pain immediately. **Constipation** is usually present and a definite **loss of weight** accompanies each attack. Patients quickly learn that certain foods increase the pain and confine themselves to fish, milk and eggs without ever having seen a doctor. **Hæmorrhage** in the form of a recognisable hæmatemesis is not a symptom but rather a complication of gastric ulceration, although small quantities of occult blood in the stools will be found in all cases. After a prolonged history most ulcers lose their intervals of remission and this implies that they have

ce is shrunken drawn and pale and the *pulse rate and temperature* re rising steadily Examination reveals tenderness and rigidity articularly above the umbilicus, and later paralytic ileus sets in nd abdominal distension and persistent vomiting become marked atures of the case.

Prognosis—The recovery rate depends on the time which is allowed) elapse between perforation and suture, on the size of the perforation nd the degree of soiling of the peritoneum Not only does the iortality depend on these factors but so does the smoothness of the onvalescence The aim of the medical attendant is to arrange for perative treatment at the earliest opportunity

Treatment—This consists in a midline or right paramedian incision bove the umbilicus, the identification of the ulcer its closure by two ows of Lembert s sutures and the careful cleansing of the peritoneal avity The necessity for drainage depends entirely upon the degree f peritoneal soiling, and not on the time since perforation If the pening is large and the stomach full at the time extensive soiling ccurs at once but a pinhole opening may need no drainage after welve hours In the presence of grave soiling a tube is placed in Douglas pouch through a stab incision above the pubes and possibly a drain to the ulcer area An occasional ulcer will be encountered whose walls are so indurated and so surrounded by oedema that closure is *impossible* It will be treated by putting a tube down to the opening and either stitching omentum over or packing gauze around it to localise the leakage A gastrojejunostomy should never be performed unless the closure of the perforation has occluded the pylorus and this occurs in less than 0 5 per cent of cases

A *great many* ulcers heal after perforation but it must be recognised that operation is only a preliminary—however essential—to medical treatment The permanent cures would be increased in number if this were more generally carried out

Subacute Perforation.—The leaking ulcer is one in which the *perforation is small*, and only a small quantity of gastric contents escapes The symptoms are less severe than in the acute cases and they clear up within a few hours. In this case the ulcer has become sealed off by a plug of omentum or by adhesions and there are no further symptoms but after some hours further leakage and another *attack of pain may* occur There is no general peritoneal involvement and the signs are limited to the epigastrium. In some cases a local abscess may follow If the condition recurs, the abdomen should be opened and the ulcer closed.

Hæmorrhage.—Hæmorrhage from a gastric ulcer may be either

1 Very slight requiring special tests for its detection
2 Moderate with small recurrent amounts insufficient to demand treatment for the actual bleeding or
3 Severe being either rapidly fatal or presenting a condition of grave emergency

The first type is present in most active ulcers and has no special significance the second indicates that treatment is urgently needed

for the ulcer rather than for the hæmorrhage and in the third group the severity of the bleeding outweighs all other considerations Severe hæmatemesis occurs in many conditions other than ulcer e g in certain grave anæmias in cirrhosis of the liver and in toxic and septic states As a complication of peptic ulceration it is seen in two different types of patient the anæmic young woman with one or many acute erosions or ulcers and the patient usually male with a chronic progressive ulcer In these people the ulceration exposes a vessel thins and softens its wall so that a small aneurysm forms and finally bursts (Fig 297) If the vessel affected is the splenic artery or another of comparable size a fatal result is a matter of minutes only but in the smaller arteries and veins bleeding continues until the fall of blood pressure allows a clot to form and seal the opening A further hæmorrhage may occur when the blood pressure rises to normal again and this second hæmorrhage may prove fatal.



FIG 297

A chronic progressive and penetrating ulcer showing the pancreas in its base together with the splenic artery which has been eroded and has ruptur d.

Symptoms are a severe hæmatemesis and collapse

Treatment is either expectant or operative in either case our outlook has changed in the past five years When due to acute erosion in young women bleeding is rarely fatal and is permanently cured by medical treatment but in chronic ulcer it is an indication that operation will be required in the near future

IMMEDIATE TREATMENT consists in absolute rest in bed preferably in a darkened room. The foot of the bed is raised on blocks a radiant heat cradle is placed over the patient and a hypodermic injection of morphia ($\frac{1}{4}$ gr) and atropine ($\frac{1}{100}$ gr) given. No feeding by mouth is allowed for twenty four hours but small pieces of ice may be sucked Blood transfusion in these patients is still a matter of controversy but it can do nothing but good if given by the constant drip method A rapid full volume transfusion is absolutely contraindicated.

SUBSEQUENT TREATMENT —Until recently a severely restricted fluid diet was considered essential. Meulengracht s technique however has entirely revolutionised treatment He advises giving an abundant diet of puree or sieved foods of great variety and high calorific value which is started within twenty four hours and continued for at least a fortnight Witt s modification to suit the people of this country has received almost universal support

OPERATIVE TREATMENT —Immediate operation recommended by Finsterer of Vienna is not generally accepted in this country Operation

must follow for every chronic ulcer after successful medical care has tided a patient over the emergency it can then be performed at leisure and without undue anxiety Should a second hæmorrhage occur during treatment a surgeon must be called without delay

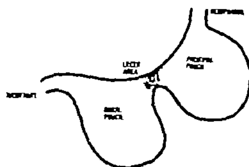


Fig. 298

A diagrammatic sketch of an hour-glass stomach.

Experience has shown that a partial gastrectomy after severe hæmorrhage with a hæmoglobin count as low as 35 to 40 per cent is not so hazardous as might be imagined. The decision to operate being made a constant drip blood transfusion is started immediately and continued throughout the operation and for twenty four hours afterwards The results of any less radical procedure are not satisfactory

Pyloric Stenosis.—This may be due to peptic ulcer or carcinoma When associated with ulcer it is due to cicatricial contracture following healing and only rarely to spasm due to an active recurrence in an already partly contracted pylorus The stomach becomes hypertrophied and dilated to enormous size The symptoms are those of an old long-standing ulcer with or without recent dyspepsia, vomiting of large quantities of partially digested and evil-smelling food rapid loss of weight and constipation. The distended stomach can easily be mapped out by percussion visible peristalsis will probably be present and an X ray photograph shows an enormous stomach and a prolonged delay in emptying



Fig 299

An X-ray of a barium meal showing an hour glass stomach. The proximal and distal pouches are well shown, as is a very large lesser curvature ulcer

Treatment —If the ulcer has completely healed a posterior gastro-jejunostomy will achieve a permanent cure but if active ulceration is present or if there is any suggestion of a carcinomatous change a partial gastrectomy should be performed.

Hour-glass Stomach —The fibrosis in this case is in the body of the stomach and results in the formation of two pouches with a

narrow connecting passage (Fig 208) Over 80 per cent occur in women and follow a saddle-shaped ulcer of the lesser curvature which spreads down on both surfaces When these patients come for advice the ulceration is soundly healed in a certain number The symptoms are those of the old ulcer and vomiting but the signs are obscure The X ray photograph however is conclusive (Fig 209)

There are several operations recommended, viz

1 Gastrogastrostomy which is an anastomosis between the pouches
2 Gastrojejunostomy into the proximal pouch
3 Gastrojejunostomy into both pouches
4 Sleeve-resection.
5 Partial gastrectomy

The ideal treatment is a partial gastrectomy If the ulcer is undoubtedly healed, a gastrogastrostomy with a wide stoma will suffice

Carcinomatous Change in a Gastric Ulcer—A radical change has come over pathological and surgical opinion on this subject since 1920 up to which time it was accepted that carcinoma commonly arose in chronic progressive ulcers A great deal of work notably by English pathologists has shown that this view is exaggerated nevertheless a very large number of ulcers are now being removed by partial gastrectomy and examined histologically and it is firmly established that carcinoma does arise in a chronic gastric ulcer though not as frequently as was previously believed In England 5 per cent. is sometimes stated as a reasonable figure in truth 0 5 per cent is probably nearer the mark

THE UNCOMPLICATED DUODENAL ULCER

The etiology and pathology of peptic ulceration in general has already been discussed but duodenal ulcers present a few minor differences which will be described here Both acute and chronic ulcers are found.

Acute Duodenal Ulcer—The frequency with which these occur is impossible to estimate They rarely lead to a fatal result and never call for operative treatment so that there is little material for examination Such post mortem statistics as are available suggest that the acute ulcer is less common than that in the stomach but there is reason to believe that the truth lies in the opposite direction. It has been customary to dismiss as hyperchlorhydria those cases in which symptoms are suggestive of but less severe than, chronic progressive duodenal ulceration and it is precisely this type of patient who probably has an acute ulcer incapable of exact diagnosis Acute duodenal ulcers are multiple in 50 per cent of cases and coexist with acute gastric ulcers in 25 per cent They are met with most commonly in men between 20 and 35 *years of age* but may occur in quite young children. There is considerable clinical evidence that acute sepsis and duodenal ulcers have an etiological relationship and their occurrence as a complication of burns is an example of this In

appearance the acute duodenal ulcer is exactly similar to that in the stomach

Symptoms differ from the typical picture of the chronic duodenal ulcer only in the duration of the attacks and of the intervals of freedom and this difference is so small that it is not always possible on clinical grounds to be sure that an ulcer is still definitely acute They occur in young men at times of hard mental work without physical exercise or in men working at high pressure under considerable nervous or emotional stress A day s relaxation playing golf may cut short an attack and a week s holiday may effect a permanent cure The pain lasts but a day or two is relieved by food, alkalis and rest and is followed by a short interval of freedom If these attacks should be allowed to continue the ulcer inevitably becomes chronic.

Chronic Progressive Duodenal Ulcer

These are more common than chronic gastric ulcers, more frequent in men (8 1) between the ages of 20 and 45 years. They affect all classes of the community but more especially the educated professional class whose work is both arduous and responsible The first part of the duodenum is the site of 95 per cent the remainder being in that section of the second part proximal to the ampulla of Vater The majority occur in the anterior wall and are rarely multiple except in the case of contact ulcers (about 10 per cent) one of which has probably been the cause of the other on the opposite wall The appearance is very similar to that of the chronic gastric ulcers and the histology is identical. Fibrosis is always present but tends to be less extensive

Symptoms —The uncomplicated chronic duodenal ulcer gives so typical a picture that in the great majority a diagnosis can be confidently made on clinical grounds alone When seen for the first time most patients give a long history beginning with a story of acute ulceration i.e. short attacks during a period of overwork or strain. After six months or a year the chronic condition is established and the attacks last for three or four weeks and the free intervals for any period up to or even exceeding, one year This periodicity is even more exact and more characteristic than in the chronic gastric ulcer Some patients notice that the attacks recur in certain seasons of the year and attribute them to sudden changes in temperature

During the attack, pain is the chief and often the only symptom It varies from being severe to a dull burning ache or to a curious feeling of discomfort combined with depression It is felt in the epigastrium sometimes on the right side and may be referred to the back or to the right iliac fossa It is described as coming on either three hours after a meal or some time before the next and is often designated hunger pain Owing to the shorter intervals between lunch and tea and between tea and dinner the pain may be felt chiefly before luncheon and some hours after dinner and it is characteristic that patients are wakened up by it about 2 A M The pain is immediately removed by food and many patients quickly learn to have a glass of milk and biscuits beside them on going to sleep and to have something in

the middle of the morning Vomiting is seldom seen unless there is obstruction The appetite is not diminished but rather is it increased and for this reason there is no loss of weight Constipation may be present and many patients complain of an unpleasant taste in the mouth During the free intervals there is complete absence of all symptoms and patients comment on their fitness Hæmorrhage in the form of occult blood in the stools is present in every duodenal ulcer but a large hæmorrhage appearing as a hæmatemesis or as a large melæna stool is not common, and should be regarded as a complication and not as a symptom.

Examination —Palpation will reveal localised tenderness over the position of the first part of the duodenum and there may be sectional rigidity of the upper right rectus muscle The fractional test meal shows increase in free HCl and total acidity in over 75 per cent of cases, and is of more useful diagnostic significance than in gastric ulcer A barium meal will usually clinch the diagnosis, a persistent deformity of the duodenal cap being direct evidence

Treatment —Medical treatment results in a rapid and permanent cure of the acute ulcers, and while the chronic ulcer remains free of complications it will hold out a fair prospect of cure but relapses are more frequent than in gastric ulcer The indications for operation are

1 Relapse after efficient medical treatment
2 Any complication.
3 If the patient has had a history of three years and over

Operative treatment includes two alternatives either a posterior gastrojejunostomy or some form of partial gastrectomy The results of the former are so poor and fraught with so many serious after effects that few surgeons practise it to-day A partial gastrectomy would appear to be a very drastic procedure for a duodenal lesion, but it must be remembered that any operation is probably useless unless it removes such a portion of the acid-secreting mucous membrane as will permanently relieve the patient of any risk of hyperchlorhydria It cannot be denied that the treatment of duodenal ulcer is still giving rise to doubt and anxiety among those physicians and surgeons who think deeply of the underlying problems (see p 634) Suffice it to say that at the time of writing no operation should be advised until there is sound evidence that the ulcer is no longer an uncomplicated one

THE COMPLICATIONS OF DUODENAL ULCER

These are

1 Penetration.
2 Perforation.
3 Hæmorrhage
4 Duodenopyloric stenosis.

Penetration occurs less frequently than in gastric ulcer but ulcers on the posterior and inferior walls of the first part and on the internal wall of the second part erode the pancreas Neglected ulcers

given either rectally or intravenously Any tendency to gastric obstruction should be countered by stomach lavage for a day or two before operation, and in such cases it is wise to leave a small tube down during the operation and for the immediate post-operative period to allow periodic suction drainage.

1 **For Infantile Pyloric Stenosis (Rammstedt's Operation).**—The infant having had his stomach washed out and emptied by tube is bandaged lightly to a well padded wooden cross. A subcutaneous saline drip should be instituted Anaesthesia is obtained by local infiltration of the abdominal wall, preferably reinforced with gas oxygen and minimal ether As little of the anterior abdominal wall as possible should be exposed warmth is essential. The incision is mid line (or right paramedian) extending down wards from just below the xiphisternum for 2 to 3 in towards the umbilicus. A finger hooks up the hypertrophied pylorus which is incised longitudinally through the serous coat only over the extent of the hypertrophied (white shining) muscle Distally this ends abruptly and an incision carried too far down the duodenum will open the lumen—not a serious contretemps if recognised (by squeezing air through from the stomach) A more common fault is not to extend the incision far enough proximally where the hyper trophied muscle usually extends for some distance up towards the cardiac end. The exposed muscle fibres are then split by the insertion of small blunt forceps until the mucosa pouts through the opening along the whole length of the incision The stomach is dropped back and the abdomen closed in layers In careful post-operative routine feeding lies the ultimate success of the operation

2 **For Perforated Gastric Ulcer**—The abdomen is opened by a 4 to 5 in. incision either in the mid line or right paramedian. Any excess fluid in the peritoneum is sucked out and the perforation identified either by vision or palpation (to expose a posterior perforation the lesser sac must be opened). The portion of the stomach which has perforated is drawn up into the incision and the hole closed either by a purse-string suture (if the surrounding induration permits) or by interrupted or a continuous seromuscular suture This line should be reinforced by sewing omentum over it—a method which in large chronic ulcers may be the only feasible means of closure

Drop the stomach back and cleanse the peritoneal cavity as far as and as quickly as possible If extravasation of stomach contents has been excessive or in old-standing cases with large perforations a suprapubic drain should be inserted. The abdomen is closed in layers

3 **Gastrostomy**—The making of a valvular opening into the stomach for feeding purposes in cases of oesophageal obstruction.

The commonly used method is that of Senn. The abdomen is opened through a left rectus muscle-split incision, a portion of anterior stomach wall *well up towards the cardia is drawn up into the wound and* a small incision made into the gastric lumen, sufficient to allow the introduction of an 18 English gastric tube (or 10 English soft rubber catheter) This is sewn to the stomach wall, some 2 in. of tube protruding into the lumen. A purse-string suture is inserted ½ in. from the tube which is pulled tight at the same time as the tube and gastric wall are pushed down into the stomach A second purse-string suture is similarly introduced, and some times a third The effect is aptly described as the "inverted ink pot" method Two catgut sutures are then inserted to draw the anterior stomach wall up to the peritoneum and the abdominal wall closed in layers around the tube An alternative method is that of Witzel in which the tube having been sewn into the stomach lumen is laid obliquely along the anterior surface and the serous coat united over it by interrupted or a continuous suture for a distance of about 3 in Another fold is then similarly drawn

over the first and the stomach sewn to the anterior parietal peritoneum as before

4 **Gastro-Enterostomy**.—This operation of short-circuiting the stomach contents into the jejunum has met with less and less favour during recent years. It is chiefly indicated when gastric obstruction provides the predominant clinical features, or when the patient for some reason is not fit to stand the major and more satisfactory operation of gastrectomy

The anastomosis can be either in front of or behind the transverse colon—the posterior route being preferred. Adhesions between posterior stomach wall and pancreas following penetration of a posterior ulcer may render the anterior route essential. In posterior gastrojejunostomy the abdomen is opened by a right supra-umbilical paramedian incision the omentum and transverse colon withdrawn and turned upwards through a non vascular portion of the transverse mesocolon (i.e. inside the middle colic arterial arcade) an aperture is made into the lesser sac and a portion of posterior stomach wall drawn through it. A clamp is applied to this portion of stomach so as to enclose about 4 in. of the wall in an approximately vertical direction. The duodenojejunal flexure is then identified and a portion of jejunum some 3 to 4 in. from this point is enclosed in a second clamp. The two clamps are then laid side by side towelled off and a seromuscular continuous suture inserted to unite the clamped portions of stomach and jejunum. The lumen of both is then opened for a length of approximately 3 in. and a through-and through suture unites the mucosal surfaces first on the posterior surface and then on the anterior. The clamps are then loosened any bleeding points undersewn, and the suture line covered by bringing the original seromuscular suture back to its starting point on the anterior surface. The clamps are withdrawn, the edges of the hole in the transverse mesocolon attached to the posterior surface of the stomach just beyond the site of the new stoma—to *prevent herniation* of the anastomosis and small intestine into the lesser sac—and the abdomen closed in layers.

In the *anterior* method similar steps are followed in the actual anastomosis, which however is carried out between the anterior surface of the stomach and a loop of jejunum some 12 to 15 in. long brought round in front of the omentum and transverse colon. This operation must be completed by performing an anastomosis between the afferent and efferent loops of the jejunum.

5 **Gastrectomy**.—For peptic ulceration and for most gastric carcinomata a partial gastrectomy is performed, some two-thirds of the distal portion of the stomach being removed. For high growths a total *gastrectomy* may be required with subsequent anastomosis of oesophagus to jejunum

The methods of performing partial gastrectomy are legion, but to-day some variation of the so-called *Polya* method is usually *adopted*. The abdomen is opened by a long right paramedian incision extending to below the umbilicus. The *greater* curvature of the stomach is cleared of the gastrocolic omentum from the first part of the duodenum to well *up* towards the cardia by clamping and ligaturing the various branches of the gastro-epiploic and gastroduodenal vessels. The *lesser* curvature is then similarly dealt with and the stomach divided between clamps preferably on the distal side of the pylorus. The duodenal stump is then carefully closed by invagination and superimposed seromuscular stitches reinforced if necessary by a covering of omentum.

The severed stomach is then turned over towards the left and the clearing of the lesser and greater curvatures continued to the level at which it is decided section will ultimately be carried out. A length of jejunum is then brought up either anterior to the transverse colon and omentum

(or through the transverse mesocolon) and attached by a continuous seromuscular stitch to the posterior stomach wall. The proximal end of the stomach is then clamped off and the remainder removed. The clamp on the proximal end is then removed and an incision made in the contiguous portion of jejunum approximately 3 in. in length A through-and through suture then unites the jejunum to the lower (greater curvature) portion of the divided stomach first on the posterior and then on the anterior surfaces The portion of stomach above (on the lesser curvature side of) the stoma so formed is sewn up separately with a through-and through stitch and the whole suture line covered by the returning seromuscular stitch from the lesser to the greater curvature The fixation of the jejunal loop to the stomach beyond the limits of the stoma, i.e on the lesser curvature side prevents subsequent kinking when the stomach and intestines are dropped back into the abdominal cavity The parietes are closed in layers.

6 **Transpleural Gastrectomy**—So difficult is the anastomosis of jejunum to œsophageal stump after abdominal total gastrectomy that carcinoma of the cardiac end is now being approached from above The 9th left rib is removed and the left pleural cavity opened. An incision is made in the left cupola of the diaphragm from the œsophageal opening outwards The stomach is freed and removed The pyloric end is closed and a loop of jejunum brought up and sutured to the œsophagus.

7 **Vagotomy**—The vagus nerves may be approached either from below or above the former being the more usual method. The nerves are identified at the cardiac orifice and divided. In most patients each nerve may consist of more than one trunk at this level and care must be taken to ensure that all branches are severed

A. E Porritt

CHAPTER XXIX

THE SMALL AND LARGE INTESTINE

THE surgical anatomy of the stomach and duodenum is described in Chap. XXVIII and of the rectum in Chap. XXXI. This section deals with the small intestine, cæcum and colon.

Development.—From the embryonic mid-gut is derived that part of the intestinal canal between the ampulla of Vater and the splenic flexure of the colon, the remaining segment of the large intestine arising from the hind gut. During fœtal life the development of the complex intestinal canal from a single loop with its median mesentery takes place in the amniotic sac. As its growth proceeds, the intestine is withdrawn into the abdomen, and by a process of rotation the normal position of the small and large intestine is obtained. Certain rare malformations in the abdomen are due to this rotation having failed to occur completely. The ileum in fœtal life is connected to the yolk-sac by the vitelline or omphalomesenteric duct, which should eventually disappear. Its persistence gives rise to the many variations of Meckel's diverticulum.

Surgical Anatomy.—The small intestine extends from the duodenojejunal junction to the ileocæcal valve, and varies between 22 and 24 ft. in length. Its coils are suspended by the mesentery and are freely movable. The large intestine begins with the mobile cæcum, to which is attached the appendix, and then has alternately fixed and mobile sections. The ascending and descending colon lie behind the peritoneum of the posterior abdominal wall, while the transverse and sigmoid colon have each a well marked mesocolon. The large bowel is easily distinguished from the small gut by its sacculation, appendices epiploicæ and three longitudinal muscle bundles. The jejunum and the ileum have certain differences which should make their differentiation reasonably easy. In the former the mesenteric arteries have only one arcade of anastomosis, and the fat does not reach the border of the intestine so that peritoneal "windows" may be seen, whereas in the latter there are three, four or even five vascular arcades, and the mesenteric fat not only reaches but encroaches on the border of the bowel.

Vascular Supply and Lymphatic Drainage.—The superior mesenteric artery, being the artery of the midgut, supplies the whole small intestine from the ampulla of Vater onwards, the cæcum, appendix and colon as far as the neighbourhood of the splenic flexure. The jejunum and ileum are supplied by the vasa intestini tenuis, the ileocolic artery dividing into ileocæcal, appendicular and right colic branches gives blood to the last 6 in. of the ileum, cæcum, appendix and ascending colon as far as the hepatic flexure, whilst the middle colic artery supplies the transverse colon and splenic flexure. Corresponding veins drain blood into the main superior mesenteric vein. The inferior mesenteric artery, the vessel of the hind-gut, supplies the remainder of the colon through its left colic, sigmoid and superior hæmorrhoidal branches, the venous blood returning to the inferior mesenteric vein. *The lymphatic drainage* of the small intestine is by the lacteal vessels into the receptaculum chyli via the glands of the mesentery

The arrangement of glands draining the colon is always constant. Along the concavity or mesocolic border are the paracolic glands, both small and numerous grouped around the main branches of the two mesenteric vessels are sets of intermediate colic glands and finally at the origin of the main vessels from the aorta is placed the main or central colic group of glands

Methods of Examination—The clinical examination of the abdomen combined with the accurate taking of case histories is of the utmost importance and no investigation is complete until a rectal, and in the female a vaginal, examination has been made. The fæces are examined for the presence of blood, obvious and occult pus mucus, blood bile pigments, organisms and parasites.

Barium meals barium enemata and radiographic examinations yield important results, and finally the sigmoid colon can be inspected visually by means of the sigmoidoscope

Congenital Anomalies

Absence and Atresia.—Absence of any part of the intestinal canal is confined to the condition known as Imperforate Anus (Chap XXXI p 675) Congenital narrowing may occur at the pylorus in the duodenum small and large intestine either in the form of septa or short lengths of narrowed and indistensible bowel



Fig. 302
A Meckel's diverticulum.

Duplication.—Parallel duplication is occasionally seen in the small bowel, the additional segment running within the mesentery and opening at one or both ends into the normal bowel It may give rise to emergency conditions due to obstruction hæmorrhage or perforation of an ulcer arising in an ectopic island of gastric mucosa

Errors in Rotation in varying degrees are not uncommon being exemplified by lack of descent of the cæcum which lies in close contact with the liver and the wholly left-sided colon the ascending lying parallel to and closely applied to the descending

Exomphalos.—Very rarely new born babes are found to have an incomplete fusion of the abdominal wall in the neighbourhood of the umbilicus at the site of which is seen a circular gap to the edges of which is attached a thin transparent membrane leading to the umbilical cord A bell-shaped sac is thus formed in which can be seen coils of intestine not yet withdrawn into the abdominal cavity

The *treatment* is immediate removal of the sac and closure of the gap in the abdominal wall

Meckel's Diverticulum.—The persistence of the omphalo mesenteric duct may lead to a variety of congenital anomalies the commonest of

which is known as Meckel's diverticulum. This consists of a blind tubular process arising from the antimesenteric border of the ileum about 30 in from the ileocæcal valve in the adult (Fig 302) It has no mesentery and its blood supply is derived from the gut wall. It is usually about 2 or 3 in. long and its apex may or may not be attached to the umbilicus by a fibrous cord

If the duct persists in its whole length, a fistula will open on the abdominal wall at the umbilicus this however is exceedingly rare

The presence of Meckel's diverticulum is not necessarily of any clinical significance but it may be the seat of acute inflammation it may form the apex of an enteric intussusception or may be directly or indirectly the cause of acute intestinal obstruction Should it occupy the sac of a hernia the special name of Littré's hernia is applied to it

Congenital Idiopathic Dilatation of the Colon (Hirschsprung's Disease)—This rare condition occurs in children, more frequently in boys than girls Its cause is not precisely known, but it is now believed to be due to spasm of muscles at the recto sigmoid junction resulting from an imperfect functioning of the sympathetic nervous system. As the accompanying X ray photograph (Fig 303) shows the colon, particularly the sigmoid and descending colon, is enormously distended, and the power of voluntary defæcation is lost Aperients have no effect and the gut can be emptied only by enemata and in the more advanced examples even they may fail to achieve any result The abdomen becomes greatly distended but remains soft and the passage of a flatus tube allows large quantities of foul-smelling gas to escape with temporary subsidence of the distension. The majority of children die before the age of 12 years from toxæmia or peritonitis but a certain number grow up into adult life with comparatively little deterioration in general health



Fig 303

An X-ray of a barium enema showing the enormously dilated colon in Hirschsprung's disease.

Treatment of recent years has been directed to the sympathetic system Telford has shown that spinal anæsthesia reaching to the anterior root of the 6th dorsal nerve achieves a complete and lasting cure No explanation is offered for this amazing result but Telford emphasises that it must be given in the early stage in childhood. A personal communication from him relates to thirteen consecutive successes

Errors in Function

Fæcal Impaction occurs too frequently as a result of prolonged unrelieved constipation and will eventually culminate in so complete a block that acute intestinal obstruction will follow A large mass of fæces collects in the sigmoid colon and upper part of the rectum, and as fluid is absorbed it becomes more solid and hard. The patient, usually a middle-aged woman, complains of colicky pain distension, nausea and constipation for many days. There is a constant desire to go to stool an attempt is accompanied by great pain and the passage of a small quantity of liquid evil-smelling fæces Examination reveals a hard mass low down in the left side of the abdomen and a finger in the rectum proves the fæcal nature of the tumour It is surprising that the condition is not infrequently seen after operations while a patient is still in bed.

Treatment consists in the injection of hot glycerin or olive oil enemata, followed an hour later by a large simple enema If this fails to produce a result the mass must be broken up into small pieces by the finger or a spoon under general anæsthesia.

A similar condition may occur in the cæcum but obstruction is not so likely to occur and the soft putty-like mass can usually be made to pass on by the use of high colonic lavage combined with oft-repeated small doses of Epsom salts

Intestinal Stasis.—Hurst has recently suggested that too much unwarranted importance is attached to chronic constipation and the supposed ill-effects which may arise from it this is infinitely more true of intestinal stasis Thirty years ago this was a fashionable complaint and many diseases even chronic mastitis of the female breast were said to be due to toxæmia derived from the putrefaction of stagnant fæcal material. Peritoneal bands and adhesions were described and named (*e.g* Lane s first and last kinks) and extensive operations for removing the whole or part of the colon practised At the present time intestinal stasis is not regarded as a clinical entity and it should be clearly understood that the treatment of constipation is purely medical and that resection of the colon short-circuiting procedures or the division of adhesions is no longer considered justifiable

Visceroptosis (Glénard s Disease) —It has been shown that the human thorax and abdomen are susceptible of arrangement in several normal types, in one of which the costal margin is unduly long the epigastric angle unusually acute and the space between the iliac crest *and the last rib very narrow This type predisposes* to general visceroptosis Pregnancy prolonged illness sedentary occupation and lack of muscular exercise all play their part in the slackening of the peritoneal mesenteries and ligaments and the gradual sagging of all or certain viscera Such ptosis is compatible with normal health and does not necessarily produce symptoms but it may tend to constipation and slight abdominal discomfort In patients with a neurasthenic background these mild symptoms may become a fixed obsession of the presence of malignant disease and the danger exists that a diagnosis of peptic ulceration cholecystitis renal disease or

intestinal carcinoma may be made. Still more frequently chronic appendicitis is suggested as the cause and the absence of improvement after appendicectomy leads to an aggravation of the neurosis

Treatment—This condition is a medical and psychological problem. Many operations for suspension or plication of the mesentery the mesocolon or the bowel itself have enjoyed a brief popularity only to fall into disfavour and it must be recognised that surgery has no part in this condition. The use of abdominal belts is also open to criticism. The object of treatment is to strengthen the abdominal muscles by massage exercises and faradic stimulation so that they can support the abdominal contents unaided. A belt merely increases the muscular atony and should be ordered only for those patients in whom active restoration treatment is contraindicated.

INFLAMMATORY DISEASES OF THE INTESTINES

ENTERITIS

Inflammation of the mucous membrane of the small intestine occurs in both children and adults from either irritation food poisoning or bacterial invasion. It is therefore of medical interest except in so far as it follows strangulation of the intestine or the improper use of drainage tubes, as a result of which a fæcal fistula may develop. The symptoms of enteritis are discomfort or griping pain in the abdomen and diarrhœa.

Treatment consists in removal of the irritant factor by thorough purgation with castor oil, followed by a bland diet and sedative drugs such as bismuth and opium

COLITIS

Colitis also comes under the care of the physician rather than the surgeon but in some of its more severe manifestations surgery is invoked to enable medical treatment to be given to better advantage. There are two varieties, namely the mucous or mucomembranous and the ulcerative

Mucomembranous Colitis is characterised by constipation and the passage of mucus in the stools. There is no real evidence of a true inflammatory process in the mucous membrane of the colon as there is in the ulcerative form It affects women rather than men and particularly those of good social and financial position in whom there is a marked neurotic element. The symptoms are mild abdominal pain obstinate constipation and the passage of mucus which will appear either as a shapeless lump or in a long strip suggestive in appearance of a tapeworm, and in some severe cases an almost complete cast of the colon may be voided.

Treatment is medical.

Ulcerative Colitis is a much more serious condition. Although no causal organism has been isolated, the pathology suggests a relationship with that group of organisms concerned with bacillary dysentery Ulcers form in the mucous membrane and may coalesce

so that large areas of the bowel are denuded of their lining membrane but the muscle is unaffected and perforation does not occur (Fig 304)

Symptoms—After a gradual onset, diarrhœa appears as the most prominent symptom and is characterised by the passage of blood mucus and pus In the severe cases there is a mild pyrexia, and the patient may pass as many as twelve motions a day The loss of blood may be such that a secondary anæmia results The disease is most intractable and is subject to remissions and exacerbations.

Diagnosis is confirmed by the bright red ulcerated mucous membrane as seen through the sigmoidoscope Carcinoma and specific forms of colitis such as amœbic and bacillary dysentery must be excluded before treatment is commenced.



Fig 304
Ulcerative colitis.

Treatment consists in rest in bed, careful dieting and regular colonic lavage daily Sulphasuxidine sometimes produces good results. Penicillin has no effect except in those unusual cases of staphylococcal origin If medical treatment has failed a terminal ileostomy should be performed the two ends of the divided gut being fixed in the abdominal wall at 2 in distance apart. For severe and intractable cases a complete colectomy is being advised by many surgeons.

DYSENTERY

Amœbic Dysentery is due to the *Entamœba histolytica* which affects the colon only stopping abruptly at the ileocæcal valve Its clinical picture diagnosis and treatment should be studied in textbooks of medicine. Its surgical manifestations are local in the bowel itself including perforation in very acute cases and fibrous stricture as a late sequela and metastatic in the liver where an amœbic or solitary abscess may form (p 719)

Bacillary Dysentery includes several types due to either Shiga's bacillus or one of the five strains of Flexner's bacillus Its surgical manifestations are not common, but a non-suppurative arthritis, particularly in the knee is a well-recognised complication

TYPHOID

Enteric fever includes typhoid and paratyphoid A and B infections of which the first is by far the most serious Both sexes and all ages are liable to the disease but the years between 10 and 35 are most commonly attacked. It is conveyed by contaminated food, water and milk supplies or by certain solids watercress having recently gained a sinister reputation.

Pathology—The *B typhosus* chiefly attacks the ileum and the Peyer's patches bear the brunt of the infection (Fig 305) These go through a series of changes namely inflammation, sloughing ulceration granulation and repair When the sloughs separate severe hæmorrhage or perforation may occur The ulcers are elliptical having their long diameter *in the long axis of the intestine* The paratyphoid infections differ only in that they affect the ascending colon as well as the ileum

Diagnosis is made by blood culture and by the Widal and Weil Felix agglutination tests

The symptoms and treatment should be studied in textbooks of medicine

Surgical Complications —1 HÆMORRHAGE of a severe nature may occur though infrequently during the third week, and may *be so copious as to necessitate a* transfusion.

2 PERFORATION also occurs during the third week and is usually seen in the more severe cases though it may affect patients during a recrudescence. *The symptoms* are a *sudden* onset of abdominal pain, shock, occasionally a rigor and tenderness and rigidity especially in the right iliac fossa.

Treatment is immediate laparotomy and suture



FIG. 305

Typhoid ulceration of the ileum showing how the infection affects chiefly the Peyer's patches.

3 PHLEBITIS *of* the *femoral* vein with thrombosis is the most frequent complication but does not occur until the patient has safely arrived at the early stage of convalescence It may result in a permanently swollen leg with an impaired venous circulation.

4 TYPHOID OSTEITIS is not uncommon. It is described in Chap XLVII.

5 ACUTE SUPPURATIVE PAROTITIS acute non-suppurative orchitis and *otitis media* are all rare sequelæ

TUBERCULOUS INFECTION OF THE INTESTINE

Although it is easy to describe the tuberculous affections in the abdomen separately the clinical picture cannot be *arranged so neatly* in separate entities for the intestinal, lymphatic and peritoneal lesions *tend to coexist in varying degrees*. The intestinal manifestations do sometimes, however occur without marked involvement either of the peritoneum or the lymph glands.

1 **Tuberculous Ulceration** affects both ileum and colon The ulcers are frequently multiple and are most numerous in the ileo-cæcal region They result from the ingestion of tubercle bacilli either in swallowed sputum or infected foodstuffs especially milk. They exhibit the usual characteristics of the chronic tuberculous ulcer with thin pale undermined edges Starting in a Peyer's patch or lymphoid follicle they spread round the circumference



FIG 306

Tuberculous ulceration of ileum. Circumferental spread of ulceration is w ll shown.



FIG 307

Tuberculous ulceration of the colon.

of the bowel by following the lymphatic vessels They are thus placed at right angles to the long axis of the bowel (compare typhoid) and the fibrosis which follows their repair tends to form a fibrous stricture so that at a later date symptoms of chronic intestinal obstruction may be expected (Figs 306 and 307)

Symptoms —The clinical picture is indefinite unless the ulceration is extensive when diarrhœa with loose watery stools occurs without the presence of blood or mucus

Treatment is purely medical until complications arise

Complications — Perforation with localised abscess formation which may be either cold or secondarily infected with bowel organisms may be seen, or obstruction from a fibrous stricture or from matting together of contiguous coils may occur and a fæcal fistula would follow the spontaneous rupture of a cold abscess through the abdominal wall. These complications are fortunately rare.

Treatment is directed towards the eradication of the infected area if possible or to the relief of the obstruction by a short circuit if adhesions render resection impracticable

2 **Ileocæcal Tuberculosis** is a rare and curiously specialised manifestation of tuberculosis It involves the cæcum terminal few inches of the ileum and the beginning of the ascending colon and the infection is largely concerned with the submucous coat, in which plane it spreads (Fig 308) This section of the bowel becomes thickened indurated and nodular and an unusual fibrolipomatous deposit is laid down beneath the peritoneum which is rough and shaggy In the later stages the mucous membrane consists of hypertrophic masses with occasional ulcers and eventually chronic obstruction follows the healing fibrosis



Fig 308

Ileocæcal tuberculosis. The infection will be seen to be more advanced in the cæcum than in the ileum.

Symptoms —(a) In the introductory stage there is a vague indefinite history of right-sided pain indigestion, loss of weight and nausea. Some tenderness may be elicited in the right iliac fossa and almost inevitably the diagnosis of chronic appendicitis is made. (b) In the intermediate stage diarrhœa with blood and mucus in the stools alternates with constipation, and on examination a tumour can be felt The diagnosis of carcinoma of the cæcum is certain unless a mild pyrexia and other signs of tuberculosis are present and inspire a bacteriological examination of the fæces (c) The final stage is one of an established chronic obstruction which is showing signs of becoming acute



Fig 309

Regional ileitis in which the inflammatory thickening is chiefly in the terminal ileum.

REGIONAL ILEITIS

Crohn s disease is an inflammatory condition of the ileum and is now a well-established entity and a large number of cases is on record. It may occur at any time between puberty and old age but the majority of patients are under 40 years Although originally described as a disease of the terminal

ileum, it is also seen in the upper reaches of the small intestine and in the colon.

The bowel is thickened and inflamed in a section between 3 and 6 ft. long the mucous membrane is swollen and ulcerated and small localised abscesses may be present in the submucous and muscular coats (Fig 309) It is characteristic of this disease for an abscess to form at the margin of the gut within the leaves of the mesentery in a recent case this had subsequently perforated into the other limb of a loop of intestine thus forming an entero-enteric anastomosis The pathology of this condition remains unknown.



FIG 310
A coil of ileum with multiple congenital diverticula.

It varies considerably in severity and presents itself clinically in two forms, one closely resembling acute appendicitis and the other producing symptoms of chronic intestinal obstruction.

Treatment is resection of the affected segment of intestine or a short circuit

DIVERTICULITIS

Congenital diverticula are found in the duodenum jejunum, ileum (Fig 310) and colon. Meckel's diverticulum has been described (p 640) while the others rarely give symptoms Acquired diverticulosis of the colon is by no means uncommon and may affect the whole large intestine but the sacs are always more numerous in (and sometimes confined to) the sigmoid colon The term diverticulitis is applied to the clinical condition arising from inflammation in the little sacs and is seen chiefly in the sigmoid

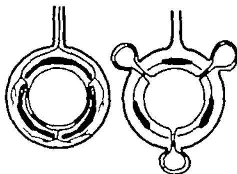


FIG 311
A diagram of transverse sections of the colon showing the anatomical sites of weakness in the muscle wall and the relation of the diverticular sacs to them.

Diverticulitis occurs more commonly in men who are over 40 years of age fat and habitually constipated. Reference to Fig 311 will show that at two (possibly three) places in a cross-section of the bowel wall there exists a normally weak spot where the blood vessels penetrate the muscular coat Chronic constipation leads to a rise in intracolic pressure which is greatly increased during the strain of defecation and at these times little sacs of mucous membrane may be forced through these weak spots frequently finding

their way into the appendices epiploicæ. In this way a double (or rarely a treble) row of sacs may be found in a length of the colon. They are devoid of muscle fibres in their walls so that while fæcal material can enter them it cannot easily find its way back into the colon. Impaction of fæces may lead to inflammation, and clinically these patients will seek advice either with symptoms of an acute abdominal emergency or for chronic left-sided pain (Fig 312)

Acute Diverticulitis closely resembles acute appendicitis in the left iliac fossa instead of in the right The nature of the inflammation its course and complications, are similar to appendicitis in almost every respect A fat constipated, middle-aged patient complains of abdominal pain centred around the umbilicus and may be sick Later the pain moves to the left iliac fossa where there will be tenderness and after a time rigidity Again just as the appendix may be lying in the pelvis so may the affected diverticulum be low down in the sigmoid colon near the rectosigmoid junction in which case the symptoms are those of pelvic peritonitis

Treatment — The inflamed diverticulum should be removed, but this is rarely possible and in many patients an abscess will have formed by the time an operation is performed

In such cases treatment is confined to drainage of the abscess Convalescence is apt to be retarded by recurrences of pain and pyrexia and in such cases a temporary colostomy should be performed.

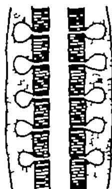


FIG 312

A diagram of a longitudinal section of the colon with multiple diverticula.

Chronic Diverticulitis is produced by a chronic inflammatory process in a row of diverticula, so that a fibrous reaction is laid down in the wall of a section of bowel, which is then thickened and narrowed These patients will present a vague history of several months duration of slight discomfort with a tendency to attacks of diarrhœa in which mucus, but not blood, is passed. This is allied to a gradually increasing constipation, which sooner or later must arouse the suspicion of the existence of a carcinoma of the colon. A bimanual examination reveals a hard and tender swelling in the region of the sigmoid colon, and only a barium enema radiographic investigation can establish a true diagnosis (Figs 313 and 314)

Treatment —In its early stages no operation is needed, but the condition should be treated on the same lines as mucous colitis A close watch is kept on the patient and if signs of chronic obstruction arise or if the radiographic findings suggest an increase in the size of the infected area or a decrease in its mobility a *resection* should be performed if adhesions permit The operative risks in such cases will be greatly diminished if a preliminary colostomy is performed and the bowel drained for six to eight weeks and by the use of sulphasuxidine

It is admitted that the treatment of diverticulitis is far from satisfactory and is causing much anxiety In many patients *extension*

of the inflammatory area in the pelvis into the os innominatum and even into the thigh is reported in spite of a well functioning colostomy Surgical opinion is veering towards radical resection at an early stage



FIG 313

A barium enema showing the presence of many diverticula in the sigmoid.

COMPLICATIONS OF DIVERTICULITIS —1 *Acute Perforation.*—The author has recently seen a lady who was undergoing treatment in a clinic to reduce her weight While seated *on the lavatory seat* and straining she was suddenly seized with such violent abdominal pain that she fainted Later a pelvic peritonitis developed and led to the formation of a large pelvic abscess A diverticulum had given way suddenly as the direct result of violent straining

Treatment consists in drainage and repair of the perforation should this be possible. It is probably wise to perform a colostomy in these cases

2. **Fistula Formation** — Chronic diverticulitis with mild attacks of perisigmoiditis may lead to adhesions to neighbouring structures the most important of which is the bladder A slowly progressive penetrating ulceration continues until the bladder is opened and a vesico-colic fistula results (Chap XXXVI) Irritability of the bladder combined with the passage of bubbles of gas in the urine may be the first indication of the diverticulitis



FIG 314

An X ray illustrating the persistence of the barium in the little pockets after an evacuation of the lower bowel.

Treatment is difficult but exceedingly important. The slightest suspicion of bladder involvement demands operation because it is easier to relieve the patient before the fistula has become established In such cases the bladder must be carefully dissected free and the damaged colon removed if possible, failing which a colostomy is performed to prevent further inflammation and to allow subsidence of that already present Six months later radiography may

reveal so marked an improvement that a resection of the colon may be planned followed by closure of the colostomy

If a fistula is present the infection of the urinary tract is of paramount importance and all further contaminations of the bladder must be prevented by diverting the fæces by means of a colostomy At a later date it may be possible to free and repair the bladder

FÆCAL FISTULA

A purposely designed colostomy and appendicostomy are examples of intestinal fistulæ but they are not included in the clinical definition of a fæcal fistula which term implies that the fistulous communication is the result of a congenital defect disease or injury These various causes may be classified as follows —

1 Congenital fistulæ seen at the umbilicus as the result of a persistent omphalo-mesenteric duct
2 Traumatic (a) penetrating wounds in military or civilian practice (b) operative factors including the ill judged retention of drainage tubes and the bursting open of an abdominal incision as the result of sepsis with the involvement of a coil of intestine
3 Necrosis of the bowel wall following acute gangrenous appendicitis acute perforative diverticulitis an unrecognised strangulation of a coil of intestine or the presence of foreign bodies such as retained swabs, etc
4 Specific causes such as tuberculosis actinomycosis and carcinoma
5 The non-recognition of a distal obstruction during operation for appendicectomy or intestinal resection and anastomosis

The fistula has either a long track leading to a deeply placed coil of intestine or no track at all in those cases in which the bowel is directly adherent to the wound. A true fæcal fistula can be readily differentiated from an abscess discharging fæcal-smelling brown pus by the oral administration of a cachet of methylene blue which will appear on the dressing in the case of a true fistula.

Treatment—Fistulæ will heal spontaneously provided that there is (1) no distal obstruction, (2) no specific infection of the track and (3) no adherence of the mucous membrane to the skin. Treatment is therefore directed to these factors but in some persistent examples operative closure will be required, and will consist in either an extraperitoneal repair or a formal resection of the adherent coil.

STRICTURE OF THE INTESTINE

Stricture of the intestine is not of common occurrence except for the malignant variety The following types are found —

1 Congenital, which have already been described on p 640
2. Infective Tuberculosis in the small bowel and syphilis and dysentery in the colon may lead to such extensive scarring that a fibrous stricture results

3 Traumatic The constriction line in a strangulated hernia is sometimes so damaged that its repair by oversewing is needed. The resulting scar tissue may contract sufficiently to cause a narrowing of the gut. Faulty technique in intestinal anastomosis may be followed by a stricture at the suture line. Impacted foreign bodies or gall-stones may produce a linear circumferential ulcer the healing of which may lead to stenosis.

4 Neoplastic which are discussed below

A stricture of the small intestine will give rise to the gradual onset of chronic intestinal obstruction, whereas in the colon the picture is likely to be more acute

Treatment consists in resection and anastomosis or a short-circuiting operation.

NEW GROWTHS OF THE INTESTINE

The Small Intestine.—*Benign* growths are very rare The connective tissue tumours are fibroma myoma lipoma fibromyoma fibrolipoma and angioma. The adenoma is the only epithelial tumour They all tend to become pedunculated either into the lumen or on the peritoneal surface The former are likely to act as the apex of an intussusception, but apart from this they are unlikely to give symptoms

Malignant growths are also rare except



FIG. 315
Multiple adenomatous polyps of the colon.



FIG 316
Multiple primary carcinomata of the colon.

that lymphosarcoma is by no means infrequent in the ileocæcal angle Carcinoma in the form of the scirrhus stricture is occasionally seen in the jejunum

The Large Intestine—*Benign tumours are rare and are similar to* those in the small bowel. Multiple adenomatous polypi (Fig 315) are quite common in the lower part of the colon but must not be confused with the polypi of irritative or inflammatory origin. They give rise to pain diarrhœa the passage of blood and mucus and secondary anæmia. If the symptoms are sufficiently severe and uncontrolled by irrigation a resection of the affected part of the colon must be considered They are of importance in that they may be the starting points of multiple primary carcinomata of the colon (Fig 316)

CARCINOMA OF THE COLON

The large intestine is one of the more common situations of cancer affecting both sexes equally

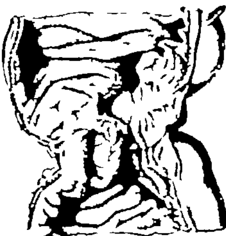


FIG 317
The scirrhus ring carcinoma of the colon.



FIG 318
Large ulcerating and fungating carcinoma of the cæcum.

Naked-eye Appearance.—1 The **Scirrhus Ring Stricture** may occur in any part of the colon except the cæcum, and is the commonest variety The growth spreads in the submucous coat around the circumference of the bowel. In its external appearance the colon shows little abnormality except that at one point it seems to have had a thick piece of string tied tightly round it but when it is cut longitudinally a narrow growth is seen encroaching on the lumen (Fig 317) Its base is rarely more than one and a half inches broad, and there is little evidence of spread either above or below the growth. The gut above bears all the signs of chronic intestinal obstruction, i.e. distension, hypertrophy and colitis with stercoral ulceration.

2. The Ulcer is relatively uncommon. It has raised and rolled



Fig. 319

Fungating carcinoma of transverse colon.



Fig. 320

Colloid carcinoma of ileocæcal region.

edges it penetrates deeply and spreads to the lymphatic glands more quickly than the other varieties

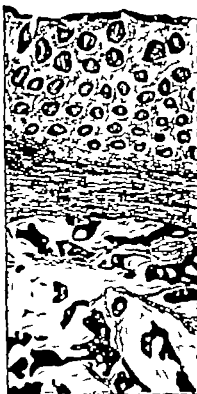


Fig. 321

A drawing of a microscopic section showing a colloidal carcinoma of the large intestine. (Kettle)

3 The **Fungating Growth** is typically seen in the cæcum (Fig 318) and ascending colon but may occur in any part of the large gut It has a broad base and grows luxuriantly into the lumen of the bowel. It does not cause obstruction and for this reason is likely to escape notice until late (Fig. 319)

Microscopic Appearance and Method of Spread.—These growths are columnar celled, usually of the adeno-carcinomatous type and tend to undergo colloid degeneration (Figs. 320 and 321)

They are not highly malignant, as they involve the main group of lymph glands late. In spite of this their prognosis especially in the right half of the colon is poor as they are advanced before their presence is revealed. Growths in the sigmoid colon however give more favourable results They tend to invade neighbouring structures and to form fistulous connections *e.g.*, a growth of the transverse colon may spread into the stomach, that of the lower sigmoid into the bladder and

in the fixed parts of the colon extraperitoneal spread with abscess formation may occur Coils of small intestine may be involved Late spread includes lymphatic involvement of the area of the portal fissure and seedling growths on the surface of the peritoneum

Symptoms—The clinical picture depends on the situation of the growth and its nature In the proximal part of the colon the contents are liquid and can continue their onward progress through even a greatly stenosed canal whereas in the distal portion solid fæces are more easily liable to arrest by comparatively minor degrees of contraction

In the proximal colon i e. the cæcum, ascending colon, hepatic flexure and proximal one-third of the transverse colon, the growth is more likely to be fungating rather than scirrhus, and these patients will present themselves for one of several reasons (1) relatives have watched with anxiety the patient getting thin and more easily tired, while the subject remains unaware of any change save that he feels rather off colour (2) there may be vague abdominal pain, loose motions or actual diarrhœa and a feeling of malaise or (3) the patient suddenly becomes aware of a tumour in the right side On examination the tumour will be palpable and occult blood will be found in the stools



FIG 333

An X ray of barium enema showing a complete hold-up of the opaque solution by a carcinoma of the transverse colon.

In the distal colon, i.e. the distal two-thirds of the transverse colon down to the rectosigmoid junction, the growth is usually an annular stricture and the picture is that of chronic intestinal obstruction with its gradually increasing constipation alternating with occasional attacks of spurious diarrhœa The tumour cannot be felt in most cases but blood and mucus are present in the stools Rarely carcinoma in any part of the colon is heralded by a severe hæmorrhage and Grey Turner has emphasised the great importance of this symptom as an early indication of cancer in the colon

Prognosis—In the proximal half of the colon carcinoma is more likely to be of the fungating type rather than annular as the contents are still liquid, obstruction is of very late appearance In the distal half on the other hand an annular stricture is more common and the fæces are now solid, with the result that obstruction is likely to bring a patient for advice at a much earlier stage For these reasons prognosis is more favourable in the left half of the colon than the right

Examination —Radiography combined with a barium enema (Fig. 322) will give evidence of the presence of the annular stricture and sigmoidoscopy will demonstrate growths of the sigmoid colon. It is necessary however to issue this word of warning The barium enema technique does not, indeed cannot, reveal the existence of all the growths in the colon and many proved carcinomata have nevertheless yielded a normal radiographic picture The conclusion to be drawn is that a negative X ray finding must not be allowed to prejudice the diagnosis when the clinical signs are suggestive

Treatment.—*A* The growth is discovered before acute intestinal obstruction has set in. The abdomen is opened in the middle line and if the growth is operable the appropriate type of resection and anastomosis is carried out at once (see below) This may be accompanied by a caecostomy to relieve the suture line of any strain from distension but this is a matter of individual choice The hazards of radical surgery in the colon have been greatly reduced by sulphasuxidine given for four days before operation

If the growth is inoperable a short circuit should be performed to avoid the subsequent development of obstruction This will not be possible in those growths low down in the sigmoid colon for which a colostomy will be required

B Acute obstruction is present and the site of the growth unknown. An immediate operation must be arranged and a median sub-umbilical incision having been made the site and operability of the growth must be investigated. If it is operable the colostomy most suitable for drainage and for the requirements of the subsequent resection is performed but if inoperable a permanent colostomy or short-circuit operation will be indicated

The procedure known as blind caecostomy in which the caecum is drained without exploring the abdomen, must be reserved for those patients whose condition is very grave as a result of late diagnosis and who would probably not survive any extensive intraperitoneal manipulations. It should be regarded only as a life-saving measure in these grave emergencies and is not to be considered as a routine procedure

R M. HANDFIELD-JONES.

OPERATIONS ON THE INTESTINE

In either large or small intestine resections there are certain principles which should be observed as applying to both

1 The actual resection and anastomosis should be performed outside a well-towelled-off general peritoneal cavity and skin incision. This may mean in the case of the colon a certain amount of preliminary mobilisation of the parts concerned. Vertical incisions to the outer sides of the ascending or descending colon through the posterior peritoneum will achieve adequate mobilisation of most of the "fixed colon."

2 In the presence of anything more than a minimal degree of obstruction any resection and anastomosis should be accompanied by proximal drainage (i e., enterostomy or colostomy) This applies in particular to the large gut

where until recently (and the advent of sulphasuxidine) a primary anastomosis after resection was seldom considered justifiable even in the absence of obstruction.

3 Occlusive clamps, to avoid unnecessary soiling during the actual anastomosis, should be applied both above and below the length of gut selected for resection.

4 Mesentery or mesocolon should where necessary be divided and vessels ligatured before the gut is resected

5 Careful study of the blood supply of the gut at the points of section is necessary—and in end to-end anastomosis the line of section of the gut should be slightly oblique—sloping back from the mesenteric border to the free border

6 There should be no tension on the line of anastomosis

7 The following methods of anastomosis are available after resection —

(a) End to-end.
(b) Side-to-side
(c) End to-side

In a typical resection the parts affected having been mobilised sufficiently to bring them outside the peritoneal cavity occlusive clamps are applied after the gut to be resected has been "milked" back to them the mesentery is then freed from the gut by either cutting it parallel to the gut or by excising a triangular area from the gut towards the base of the mesentery Vessels are ligated. The gut is then doubly clamped at either end of the portion to be resected and cut (preferably with diathermy) between the clamps If end to-end anastomosis is intended clamps must be spring clamps if side-to-side crushing clamps and the ends of the bowel ligatured at the site of crushing In this latter case a purse-string suture is then inserted just beyond the ligature which is then inverted and the purse-string closed after which the two blind ends are laid side by side and anastomosed by the usual seromuscular and through-and through sutures after opening The end to-end anastomosis can be performed either using clamps or tension sutures, similar seromuscular and through-and through sutures being used.

Particular care must be taken at the mesenteric border (the so-called "dangerous angle") and an occasional lock-stitch prevents over narrowing of the lumen. Finally the gap in the mesentery or mesocolon is closed by a few interrupted catgut stitches and the gut returned to the abdomen, which is closed in layers.

A. E. PORRITT

CHAPTER XXX

INTESTINAL OBSTRUCTION

INTESTINAL obstruction is a condition in which the normal onward passage of intestinal contents is prevented either by a mechanical or a paralytic cause and is to be distinguished from constipation, in which fæcal evacuation is merely delayed by a sluggish intestinal musculature The classification of the causes of intestinal obstruction can never be a simple matter but it is highly desirable that the mechanical causes should be kept entirely separate from those in which the bowel muscle is paralysed, because the clinical picture and the treatment are so different

MECHANICAL OBSTRUCTION

This type of obstruction which comprises the majority of cases, manifests itself clinically in three varieties viz acute chronic and chronic obstruction which is becoming acute These must be described separately

ACUTE INTESTINAL OBSTRUCTION

Causes—Acute obstruction is due either to pressure upon the intestine from without, to a pathological or developmental process causing contraction of its wall or to the blockage of its lumen by some solid substance inside it. If the obstruction is due to impaction within the lumen or to stenosis of the gut-wall, or if a peritoneal band passes across the intestine in one place only a mechanical block will be established but if the band passes across the bowel in two places or if a loop of gut is caught by any means *e.g* the opening of a hernial sac the blood vessels of the mesentery of the loop are obstructed also and strangulation" will occur The causes of acute obstruction, therefore, are classified as follows —

Obstruction with Strangulation (63 per cent)

1 In external herniæ (45 per cent)
2. In internal herniæ (2 5 per cent)
3. By bands (11·4 per cent.)
   (a) Peritoneal adhesion
   (b) Meckel s diverticulum.
   (c) Appendix
   (d) Great omentum.
4 Intussusception (15 per cent)
5 Volvulus (2·6 per cent.)

Mesenteric vascular occlusion is not included here as is usually done but is described under Paralytic Obstruction (p 670)

Obstruction without Strangulation (38 *per cent*)

6 Adhesions (7·4 per cent.)

7 Congenital malformations (0·6 per cent)

(*a*) Atresia of small gut.

(*b*) Atresia of large gut.

(*c*) Imperforate anus.

8 Impaction of gall-stones (0·7 per cent)

9 Impaction of foreign bodies (0·3 per cent)

10 Growths of intestine

11 Diverticulitis.

12 Fibrous stricture.

13 Pressure from without [1]

Pathology— *A* **Without Strangulation.**—The intestine above the obstruction becomes progressively distended with gas and fluid while the gut below is empty and in spasm, being white and firmly contracted. The degree of distension depends upon the site of the obstruction and the time which has elapsed since its onset Generally speaking it is most marked in large intestine obstruction, and becomes less prominent as the site of the lesion rises in the intestinal tract the greatest distension occurring in volvulus of the sigmoid colon the least in a high jejunal obstruction. The gut-wall becomes very thin and at first is pale then red and cyanotic, but only in neglected cases will it be so damaged as to permit the passage of organisms into the peritoneal cavity



FIG. 323

A loop of ileum which had become gangrenous in a strangulated femoral hernia. The constriction line can be well seen. The proximal part of the intestine (on the left) is markedly distended.

B **With Strangulation.**—The intestine above and below the strangulated gut are in the same condition as in simple obstruction, but the loop itself will show the effects of vascular compression (Figs. 323 and 324) In the first few hours the pressure is sufficient to occlude the veins only so that the loop becomes distended, swollen œdematous and deep blue in colour owing to *venous congestion* Blood and mucus escape into the lumen and a blood-stained effusion is secreted by the peritoneal coat. As the tension in the loop rises a time will come when the arterial pressure is overcome and *gangrene* of the loop inevitably follows The gut now becomes black the peritoneum loses its shiny lustrous appearance organisms pass out into the blood-stained exudate and local or general peritonitis rapidly supervenes It is important to realise that these changes will be more advanced in both time and severity along the line of compression of the intestine by band hernial orifice or other cause.

GENERAL SYMPTOMS —The general condition of the patient is so

[1] These are only rarely causes of acute obstruction without previous history of chronic obstruction.

CHAPTER XXX

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7 Congenital malformations (0·6 per cent.)

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11 Diverticulitis.
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General Symptoms —The general condition of the patient is so

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typical that minor adjustments and additions only will be needed in the description of the various causal diseases

Pain is the first symptom It is severe abrupt in onset and is centred around the umbilicus or less commonly generally over the abdomen. After the first few hours, colicky griping pains due to violent peristalsis are added to the constant dull sickening ache. In untreated patients the picture changes as peritonitis sets in, the colicky pain disappearing and the dull ache diminishing In strangulation of an external hernia pain will also be felt in the region of the hernial swelling.

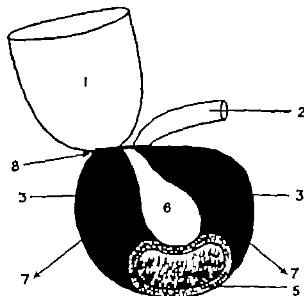


FIG 324

Diagram illustrating the pathology of "closed loop" strangulation.

1 Proximal coil grossly distended and thin.
2 Distal coil contracted and in spasm.
3. The closed loop.
4. Lumen filled with blood and mucus.
5. Wall thickened by venous congestion, oedema, and interstitial haemorrhage.
6. Mesentery f closed loop, congested and oedematous.
7 Blood-stained serum being poured out into hernial sac or general peritoneal cavity
8. *Arrow points to constricting band or ring of hernial orifice.*

Vomiting occurs at once and consists of one or more attacks in the first half hour It then ceases for a time until the true persistent vomiting of obstruction is established The interval depends on the site of the obstruction, and the vomiting and the distension may be said to be inversely proportional to one another In high jejunal obstruction distension is slight and the vomiting quickly sets in, *while in a low colon* lesion the distension may be enormous, but the vomiting does not come on for forty-eight *or more hours.* At first the vomit consists of stomach contents then green bile is the chief constituent and later it becomes brown and more and more offensive. In the early stages it is projectile in type but later large quantities of so-called faecal vomit seem to pour out of the mouth without any apparent movement of the patient.

Absolute Constipation.—Within half an hour of onset there may be an action of the bowel, after which neither faeces nor flatus are passed either voluntarily or in response to enemata (see below) **Thirst** soon becomes an urgent symptom patients ceaselessly demanding more and more to drink.

GENERAL SIGNS —*1 Shock is present in all cases with strangulation*

but is absent or slight in others. The patient wears an anxious expression the face is pale and bathed in a cold sweat the pulse is thin and weak, and the temperature is subnormal The pulse rate slowly returns to normal and gradually becomes quicker but the temperature will not rise above normal until peritonitis has set in

2 **Distension** has already been referred to It is important to differentiate between that formed by the large gut and that by the small, as this may have an important bearing on treatment It is quite impossible to do so in many patients and there is no infallible test, but colon distension fills up the flanks and the epigastrium, leaving an impression of a flat soft central plateau in the abdomen whereas small gut distension balloons the centre and does not encroach to the same extent on the flanks and epigastrium.

3 **Reaction to Enemata.**—Blind reliance on enema tests cannot be too strongly deplored. An enema given soon after onset may produce both flatus and a fæcal result A second enema given half to one hour later will produce no result and will need to be syphoned back. Herein lies the true worth of the enema test but it must be realised that one enema may prove misleading

4 **Other Abdominal Signs.**—In many cases there will be none but in intussusception external herniæ and some growths the tumour can be felt either through the abdominal wall or per rectum, and in intussusception blood and mucus will be found in the rectum.

5 **Absence of Other Abdominal Signs.**—*Tenderness and rigidity* are *absent* until the onset of peritonitis, by which time the prognosis is very bad. The abdomen moves with respiration the anterior abdominal wall is soft, flaccid and only in very rare cases is there localised tenderness. The absence of these two signs is of the greatest importance Visible peristalsis is sometimes described as a sign of acute obstruction that is a grave mistake and a most dangerous doctrine It is true that even normal peristalsis may be seen in very thin old people but it is essentially a sign of chronic obstruction which is threatening to become acute and in which the bowel is hypertrophied as well as distended We wish to emphasise that it is the absence of these signs which form so strongly positive a link in the chain of early diagnosis.

6 **Late Signs.**—Peritonitis brings its own signs but one result of the vomiting is a rapid dehydration of the body The Hippocratic countenance is only too typically present with its pallor its shrunken features its hollow orbits and sunken eyes

These signs are somewhat altered in a strangulated external hernia in which pain is felt in the swelling which becomes tense and tender otherwise the picture is similar

GENERAL DIAGNOSIS —The high mortality in acute obstruction has always been a matter of grave concern, and much anxious research has been directed to this subject but the absolute essentials for success are early diagnosis and prompt operation The clinical picture detailed above should suffice to satisfy the practitioner of the *presence* of obstruction He should also attempt to define the site and the *nature* of the lesion A careful history is taken all hernial orifices examined

a rectal or vaginal examination performed and the distension investigated to distinguish (if possible) large from small gut obstruction. Percussion and auscultation of the cæcal region may give valuable evidence

The differential diagnosis includes all acute abdominal emergencies and all types of colic The absence of tenderness rigidity and pyrexia excludes all the inflammatory diseases and the ruptures of viscera. The history should suffice to eliminate biliary and renal colic and tabes is excluded by investigating nervous reflexes and the pupil reactions There should be no difficulty in differentiating the mechanical from the paralytic obstruction provided the small intestine is carefully listened to by stethoscope Excessive gurglings are heard in mechanical obstruction silence reigns in paralytic ileus Auscultation of the abdomen does not receive the attention it deserves. Elementary errors in diagnosis and prognosis are made simply because a stethoscope has not been used.

GENERAL TREATMENT —Acute obstruction being a clinical syndrome and not a pathological entity treatment is directed to the relief of its cause and the evacuation of the distended bowel. When the nature of the obstruction can be recognised, *e.g* a strangulated external hernia or an intussusception, appropriate treatment is adopted, but in many patients the lesion is intra-abdominal and neither its site nor its type can be defined In such cases the abdomen is opened in the middle line below the umbilicus and the cæcum is palpated. Its distension points to a large gut obstruction and its collapse to a small gut lesion. The most distended coil of small gut tends to present in the wound and if this is gently followed the obstruction should be close at hand and quickly discovered and appropriate measures taken to overcome the cause If the general condition is bad and the gut greatly dilated, a jejunostomy used to be practised to drain away its toxic contents. Similarly a patient may be so gravely ill having vomited persistently for several hours that any operation seems too dangerous a cæcostomy or jejunostomy used to be advised. To-day these procedures have given place to intestinal drainage via a Ryle's duodenal tube the full technique of which is given on p 671

STRANGULATED HERNIÆ AND STRANGULATION BY BANDS

1 **Strangulated External Hernia** (Chap XXVII)

2. **Strangulated Internal Hernia.**—There are a number of peritoneal fossæ into which coils of intestine may enter They are situated around the duodenojejunal junction near the cæcum and in the mesentery of the sigmoid colon. The foramen of Winslow has been known to transmit coils of small gut into the lesser sac and the opening in the transverse mesocolon in the operation of posterior gastrojejunostomy has also served as a hernial orifice. Strangulation in all these situations may occur and will give a typical picture of acute obstruction with no indication of its cause (Fig 335) Immediate operation is needed to release the intestine

3 **Bands.**—(*a*) Peritoneal bands and adhesions result from previous

inflammation of the peritoneum appendicitis salpingitis and in flammation of the mesenteric lymph glands being common examples. Surgical trauma may also produce adhesions particularly if raw areas are left in the abdomen uncovered by peritoneum Such adhesions may be wide flat thin sheets or single rounded cords the latter being more likely to cause acute obstruction than the former These bands stretch usually from the mesentery to some other abdominal structure or to the parietes

(*b*) Meckel s diverticulum may be attached to the umbilicus by a fibrous cord or its end may have been free but have become secondarily attached by inflammation to the mesentery a coil of intestine or the posterior abdominal wall. In any of these conditions the diverticulum may act as a band, under which a coil of small intestine may become strangulated.

(*c*) The appendix or the great omentum may become attached in a similar manner and likewise act as a band.



FIG. 225

A hole in the mesentery of the small intestine through which coils of intestine have prolapsed. An example of a strangulated internal hernia.

Bands of whatever nature act in one of two ways either a short tense band compresses a loop of intestine, which has slipped beneath it or a long lax band forms a noose through which the loop slides

Symptoms —This type of acute obstruction usually affects the small intestine in the lower reaches of the ileum. The onset is abrupt, the pain severe the shock marked the distension moderate and persistent vomiting is established within a few hours

Treatment —The abdomen having been opened below the umbilicus free fluid, either clear or blood-stained, is immediately apparent and the site of the obstruction is quickly found by gently following the most distended loop The band is carefully examined and when proved to be a thickened peritoneal adhesion (and not a coil of intestine) it is divided. The appendix, or Meckel s diverticulum if acting as the band should be removed unless the general condition prohibits anything but essentials The strangulated coil is carefully examined and, if its vitality is assured, the compression groove is closely scrutinised for it may show early gangrene ulceration or perforation long before the loop is affected. Any weakness at this line can be remedied by oversewing If the viability of the loop is in doubt the wisest procedure is to wrap it up in hot moist packs for three minutes after which its colour and pulsation will have returned and peristalsis may be elicited. When the gut is obviously gangrenous a resection with end to-end anastomosis is performed The amount to be removed depends on the degree of distension in the proximal coils The gut below the dead loop is divided as near to the

compression line as is convenient but the proximal gut must not be cut across until a reasonably healthy coil has been discovered Before the abdomen is closed a careful search must be made to exclude the presence of a second band

After-treatment is important Immediately on the patient's return to bed, a continuous intravenous drip saline is started. As soon as he has recovered consciousness he is placed in Fowler's position. Small sips of iced water are given as frequently as desired. Morphia may be given only if essential and then in doses of $\frac{1}{12}$ gr The following medicine is to be given in doses of ½ oz. four hourly :—

℞	Eserin Sulphate	aa gr $\frac{1}{30}$
	Strychnine Hydrochlor	
	Syrup Limonis.	ʒſs.
	Aquam	ad ʒſs.

If all goes well a turpentine enema is given at the thirty-sixth hour This should give a good result vomiting should have ceased and the danger be over If vomiting persists, and the general condition fails to improve the patient is threatened with paralytic ileus and treatment is directed toward that condition (see below)



FIG. 326

A diagram showing the component parts of an intussusception.

S, the sheath ;
R, the returning layer ;
E, the entering layer
A, the apex
N the neck ;
M, the mesentery

INTUSSUSCEPTION

This remarkable condition entails the invagination of one part of the intestine into that immediately below it, followed by a progressive advance of the invaginated portion, so that more and more intestine is drawn up within the outer layer

It will readily be understood that in the affected segment three layers of intestine are involved The part which first becomes invaginated is known as the *apex* and this remains constantly in the lead of the advancing invagination. The three layers are the *entering layer* which turns over at the apex to become the *returning layer* and this in turn joins the *outer* or *ensheathing layer* The invaginated portion viz. the entering and returning layers is also referred to as the intussusceptum, and the sheath as the intussuscipiens. As the invagination proceeds onwards its increase in length is always at the expense of the outer ensheathing layer Clearly the intestine cannot take part in this process without dragging with it its mesentery which comes to lie between the entering and the returning layers The point at which it enters is known as the *neck* As more and more gut becomes drawn in, the congestion at the neck increases till finally the veins of the mesentery are compressed. The intussusceptum is therefore closely analogous to the loop of a strangulated hernia with the one exception that it is not a closed loop but points forward into the distal intestine (Fig 326) The venous congestion leads to swelling and oedema of the intussusceptum most marked at the apex as a result of which blood

and mucus are poured out into the distal intestine Later the peritoneum is involved and a local plastic peritonitis fixes together the entering and returning layers and the intussusception is now irreducible If the condition remains unrelieved the intussusceptum finally becomes gangrenous and cases are recorded in which it sloughed away and was passed per rectum.

The Causes of Intussusception include any source of irritation or a tumour in the lumen or in the wall of the intestine which stimulate over violent peristaltic waves in an effort to expel the trouble In practice the acute intussusception in infants is almost always due to swollen Peyer s patches and the chronic variety to either benign or malignant tumours (Figs. 327 and 328)

The Types of Intussusception are classified as follows —

1 Enteric (10 to 15 per cent)
2 Enterocolic (75 to 80 per cent) ileocæcal / ileocolic.
3 Colic (5 to 10 per cent.)

The ENTERIC type affects the small gut only It occurs in children under 10 years of age in whom it is always due to an obvious cause such as a polyp a Meckel s diverticulum or a tuberculoma, and in adults who have a malignant tumour of the intestine

The COLIC type affects adults *only and is due to a malignant* tumour of the colon.

The ILEOCÆCAL type is commonest of all. In it the ileocæcal valve is the apex and the ileum is invaginated into the colon. In infants the mesentery is so long that the intussusception may go right through the colon and present at the anal orifice In the Ileocolic variety the invagination begins as a pure enteric intussusception about 6 in from the ileocæcal valve Soon the ileal apex passes through the valve and the colon is then involved (Figs 329 and 330)



FIG 327

A lymphosarcoma of the ileum causing an intussusception.

Acute Intussusception occurs in infants under 2 years of age more commonly in boys than girls and usually chooses the fittest and fattest It is most commonly associated with weaning The child having thrived on its mother's milk does not settle down quickly and comfortably to artificial feeds A mild attack of enteritis follows with relaxed and foul-smelling motions.

This leads to engorgement and swelling of the Peyer's patches in the terminal ileum which act as the stimulus to violent peristalsis.

Symptoms.—The baby is seized with an attack of abdominal pain of a colicky nature which lasts about a minute. These attacks recur at regular intervals of a few minutes. During the attack the child curls itself up and screams loudly while its face becomes very pale. In the intervals the colour returns, but the child lies unusually quiet. The bowels will be emptied during the first few spasms and later blood and mucus may be passed. Vomiting is not a feature of this condition.



Fig. 328

Multiple papillomata causing an intussusception.

Signs.—The abdomen is soft and the tumour should be palpable as a soft sausage-shaped swelling which rapidly hardens as the spasm of pain comes on. It is slightly curved, having the concavity facing towards the umbilicus. The right iliac fossa gives the impression of being curiously empty. If any difficulty is experienced a finger should be introduced into the rectum, when a bimanual examination can hardly fail to discover the tumour and in addition, the finger will be covered with blood and mucus. The diagnosis should never be in doubt though Henoch's purpura may give difficulty in rare cases.

Treatment.—Immediate laparotomy is called for. The abdomen is opened through a right paramedian incision and two fingers are introduced and seek for the apex. Gentle pressure from below causes the invagination to slide backwards, and in some cases it runs back so quickly that the finger fails to keep in contact with it. Reduction is complete except for the apex, and the tumour is now withdrawn from the abdomen and surrounded with hot, moist packs and gently and progressively compressed from the distal aspect. Under no circumstances whatever may the entering layer be pulled on. Within a minute or two the reduction is complete but care must be taken to ensure that the last dimple is reduced.

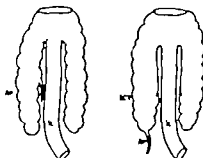


Fig. 329 — A diagram illustrating an ileocaecal intussusception. I.C.V., the ileocaecal valve; IL., the ileum; and Ap., the appendix.

Fig. 330 — A diagram illustrating an ileocolic intussusception. The references are the same as those in Fig. 329.

If the intussusception is irreducible and its walls gangrenous, the

whole area must be resected but the results are very bad If the sheath is not gangrenous it is opened vertically and the intussusceptum is cut off at the neck the cut margins being united by a circular stitch (Jesset s operation) Fortunately very few cases are irreducible for in them the mortality rate is high

Contrary to all expectation recurrence after reduction is exceedingly rare

Chronic Intussusception is a rare condition in adults over 60 years of age being usually due to carcinoma of the colon The story is that of chronic obstruction and may last for several weeks. Blood and mucus appear in the stools constipation is present and mild colicky pains occur The condition is readily diagnosed by a barium enema and the treatment is directed to its cause Multiple and retrograde intussusceptions are described, but occur only as a terminal manifestation at the approach of death.

VOLVULUS

A volvulus is produced by the twisting of a coil of intestine on the axis of its own mesentery so that not only is the lumen obstructed at each end but the vessels are compressed. It occurs in the sigmoid colon, the cæcum and the small intestine

Volvulus of the Sigmoid Colon is unlikely to occur in a normal sigmoid colon and mesosigmoid. The freely movable sigmoid loop is fixed at each end, above at its origin from the descending colon and below at the rectosigmoid junction. These fixed attachments are normally some distance apart but perisigmoiditis leads to the formation of thickened bands in the mesocolon. The contraction of these bands draws the fixed ends of the loop into close contact. A narrow pedicle is thus formed, allowing facile rotation of the loop An overloaded sigmoid colon will hang down into the pelvis and some irregular movement may cause it to turn over The lumen at each end becomes obstructed gas rapidly forms, and in a short time untwisting is not possible. The analogy of the closed loop pathology is here perfect (see general pathology above) as both the gut and its vascular supply are obstructed and the results are similar in all respects

Symptoms—Volvulus of the sigmoid colon occurs in both sexes after the age of 45 years There is a sudden attack of abdominal pain with an initial single vomit The symptoms are not so severe as in other forms of strangulation, but the distension rapidly becomes enormous the huge sigmoid loop filling the entire abdominal cavity and causing both respiratory and cardiac embarrassment. Its extent must be seen to be believed, and it provides a sure guide to early diagnosis

Treatment consists in immediate operation under spinal anæsthesia. A large paramedian incision exposes the distended loop An attempt is made to pass a flatus tube from below while the surgeon endeavours to guide its nozzle into the loop This is rarely successful and must not be tried if the distension is very great The rotation must be untwisted but this will not be possible in many cases until the gas

has been let out through a small puncture in the gut If nothing else is done the volvulus is likely to recur and the sigmoid loop should be fixed. The only satisfactory method is to do a colostomy which has the advantage of draining the loop At a later date an extraperitoneal closure gives permanent fixation with a restored lumen

Volvulus of the Cæcum occurs only when the mesocolon of the ascending colon persists. The twist of the cæcum produces a picture of acute obstruction, but the exact diagnosis is unlikely to be made until operation.

Treatment consists in laparotomy and untwisting the cæcal rotation

Volvulus of the Small Intestine is very rare but very severe The picture is that of a small gut obstruction, and the abdomen must be opened at the earliest opportunity

FIG 331

A large gall-stone firmly impacted in the intestine causing acute intestinal obstruction.

GALL-STONE OBSTRUCTION

Gall-stones large enough to become impacted in the intestine enter the duodenum or the hepatic flexure of the colon as the result of an ulcerating cholecystitis The colon usually transmits the stone without impaction, but in the small gut the stone is held up at its narrowest part 39 in. from the ileocæcal valve (Fig 331) Elderly women are most commonly affected and they have suffered from recurrent attacks of g nd cholecystitis (but not of colic or jaundice) during the rs. The impaction produces an attack of acute ab ck and distension are not marked Vo ng is It may be possible on rare occa iliac fossa No difficulty will be ex gently pushed upwards into a h

A similar clinical picture is t enteroliths and those swallowed a

CHRONIC INTE s

Chronic obstruction is due the intestinal canal, so that th

more difficult It is usually met with in the colon Its causes may be classified as follows —

A Extrinsic—
1 Adhesions
2. Pressure from without as by tumours, etc.

B Intrinsic—
3 Strictures — Inflammatory / Traumatic / Neoplastic.

4 Carcinoma of colon and rectum
5 Chronic diverticulitis
6 Chronic intussusception.
7 Chronic volvulus
8 Ileocæcal tuberculosis
9 Ileocæcal actinomycosis.
10 Fæcal impaction
11 Hirschsprung's disease
12 Chronic regional ileitis

Pathology—The intestine above the obstruction is moderately distended and greatly hypertrophied (Fig 332) A catarrhal inflammation of the mucous membrane follows and later stercoral ulcers develop

Clinical Picture.—The cause of the obstruction is not always apparent but in many patients it will produce its own symptoms before the obstruction has become a prominent feature In the unheralded variety the patient complains of a gradually increasing constipation and after a considerable time (possibly many months) there will be a mild degree of colicky abdominal pain, distension, flatulence and gurgling sounds made which may be embarrassingly evident Later still alternating with the constipation there are attacks of "spurious" diarrhœa due to the colitis stercoral ulceration and putrefactive changes in the delayed fæces The patient complains of malaise loss of weight, and although unable to be precise he will be convinced that "something is not quite right inside."



Fig 332.

A portion of ileum showing a tuberculous stricture above which the gut is distended and greatly hypertrophied. The patient came to operation with acute obstruction due to the impaction of a damson stone (in the test tube) in the stricture.

An abdominal examination reveals a moderate degree of distension with visible peristalsis which may even produce the typical "ladder" pattern. Careful investigation by palpation, percussion auscultation and a rectal examination should indicate the site of the obstruction. These cases terminate in acute obstruction, in peritonitis due to the perforation of a stercoral ulcer or from reasons connected with the primary cause.

Treatment is essentially operative and is directed to the cause If this should prove to be inoperable a colostomy or an anastomosis will be needed.

Chronic Obstruction Becoming Acute hardly merits the distinction of a separate category A study of the pathology of chronic obstruction suggests that a complete blockage is likely to occur if

has been let out through a small puncture in the gut. If nothing else is done the volvulus is likely to recur and the sigmoid loop should be fixed. The only satisfactory method is to do a colostomy which has the advantage of draining the loop At a later date an extraperitoneal closure gives permanent fixation with a restored lumen

Volvulus of the Cæcum occurs only when the mesocolon of the ascending colon persists. The twist of the cæcum produces a picture of acute obstruction but the exact diagnosis is unlikely to be made until operation

Treatment consists in laparotomy and untwisting the cæcal rotation.

Volvulus of the Small Intestine is very rare but very severe The picture is that of a small gut obstruction, and the abdomen must be opened at the earliest opportunity

Fig 331

A large gall-stone firmly impacted in the intestine causing acute intestinal obstruction.

GALL-STONE OBSTRUCTION

Gall-stones large enough to become impacted in the intestine enter the duodenum or the hepatic flexure of the colon as the result of an ulcerating cholecystitis The colon usually transmits the stone without impaction, but in the small gut the stone is held up at its narrowest part, 30 in. from the ileocæcal valve (Fig 331). Elderly women are most commonly affected and they have suffered from recurrent attacks of gall-stones and cholecystitis (but not of colic or jaundice) during the preceding few years. The impaction produces an attack of acute abdominal pain, but shock and distension are not marked Vomiting is a prominent symptom. It may be possible on rare occasions to feel the stone in the left iliac fossa No difficulty will be experienced at operation, the stone being gently pushed upwards into a healthy coil of gut and removed

A similar clinical picture is given by other foreign bodies, such as enteroliths and those swallowed but these are very rare

CHRONIC INTESTINAL OBSTRUCTION

Chronic obstruction is due to a slowly increasing narrowing of the intestinal canal so that the passage of its contents is rendered

more difficult It is usually met with in the colon. Its causes may be classified as follows —

A Extrinsic—

1 Adhesions
2 Pressure from without as by tumours, etc.

B Intrinsic—

3 Strictures—Inflammatory, Traumatic, Neoplastic.
4 Carcinoma of colon and rectum.
5 Chronic diverticulitis
6 Chronic intussusception.
7 Chronic volvulus
8 Ileocæcal tuberculosis
9 Ileocæcal actinomycosis
10 Fæcal impaction.
11 Hirschsprung's disease
12 Chronic regional ileitis

Pathology—The intestine above the obstruction is moderately distended and greatly hypertrophied (Fig 332) A catarrhal inflammation of the mucous membrane follows and, later stercoral ulcers develop



FIG. 332

A portion of ileum showing tuberculous stricture, above which the gut is distended and greatly hypertrophied. The patient came to operation with acute obstruction due to the impaction of a damson stone (in the test tube) in the stricture.

Clinical Picture.—The cause of the obstruction is not always apparent but in many patients it will produce its own symptoms before the obstruction has become a prominent feature In the unheralded variety the patient complains of a gradually increasing constipation and after a considerable time (possibly many months) there will be a mild degree of colicky abdominal pain, distension, flatulence and gurgling sounds inside which may be embarrassingly evident. Later still alternating with the constipation, there are attacks of spurious diarrhœa due to the colitis stercoral ulceration and putrefactive changes in the delayed fæces The patient complains of malaise loss of weight, and although unable to be precise he will be convinced that something is not quite right inside

An abdominal examination reveals a moderate degree of distension with visible peristalsis, which may even produce the typical ladder pattern Careful investigation by palpation percussion, *auscultation* and a rectal examination should indicate the site of the obstruction. These cases terminate in acute obstruction, in peritonitis due to the perforation of a stercoral ulcer or from reasons connected with the primary cause

Treatment is essentially operative and is directed to the cause If this should prove to be inoperable a colostomy or an anastomosis will be needed.

CHRONIC OBSTRUCTION BECOMING ACUTE hardly merits the distinction of a separate category A study of the pathology of chronic obstruction suggests that a complete blockage is likely to occur if

appropriate treatment of the cause has not been undertaken at a sufficiently early stage.

PARALYTIC OBSTRUCTION

The cessation of all intestinal movements due to paralysis of the muscles produces a clinical picture closely akin to acute intestinal obstruction, but no form of mechanical blockage is present It can unquestionably be called the most terrible complication of abdominal disease There are two types viz paralytic ileus and mesenteric vascular occlusion

PARALYTIC ILEUS

This may be the result of the following conditions —

1 Inflammatory as a complication of local or general peritonitis.
2 Toxic as in uræmia and lead poisoning
3 Neuropathic when the spinal cord and the peripheral nerves are diseased or compressed.
4 Traumatic after rough handling of intestine or pulling on the mesentery during operations

The inflammatory type of ileus usually occurs after operation for some abdominal lesion accompanied by spreading peritonitis. The more rapid and more virulent infections are characterised by a dirty offensive sero-purulent effusion into the peritoneal cavity with few protective adhesions These are the conditions which favour the onset of ileus Thick yellow pus however offensive in smell, is not of such dangerous significance This type of paralysis is in the nature of a protective reflex much as is muscular rigidity in diseases of joints Active peristalsis must spread inflammatory exudates, whereas immobility of the intestine tends to localise the peritonitis

Symptoms—After operation the post-anæsthetic vomiting having subsided, a period of twenty four to thirty-six hours follows in which the patient's progress seems as favourable as could be expected. At the end of this period the improvement is not maintained, the abdomen becomes more distended and the patient has occasional attacks of vomiting There is some slight pain, temperature and pulse rate are slowly rising and enemata fail to produce a result Such is the picture of a threatened paralytic ileus If treatment fails the distension increases and the vomiting continues the pulse becomes weaker and more rapid and later the temperature falls below normal. Profuse effortless vomiting of the fæculent type follows a profound toxæmia develops and death rapidly ensues

Treatment—*A* Prophylactic.—Experience rapidly teaches a surgeon to recognise the type of abdominal emergency which is likely to develop ileus He must also be satisfied that the peritoneum has been efficiently drained and that no pockets of pus remain untapped These patients should be given an eserine and strychnine mixture (p 604) every four

hours until the danger is past. Sulphadiazine is useful in infections due to *B coli* and hæmolytic streptococci penicillin will be a valuable reinforcement if the organisms are sensitive

B **Early Cases.**—As soon as there is a definite threat of ileus active steps must be taken to support the patient s strength until the infection has been mastered and intestinal tone restored No attempt is to be made to produce evacuation of the bowel by aperients given by mouth but gaseous distension of the colon may be relieved by the passage of a rectal tube or a simple enema Two grave conditions demand attention first marked dehydration which is a feature of this disease and second, the toxæmia from the highly poisonous contents of the small intestine A constant drip of intravenous glucose saline will be started immediately the diagnosis is made At the same time a Ryle s duodenal tube or a Miller Abbott modification is passed via the external nares and swallowed by the patient until its nozzle is in the duodenum Through it the toxic intestinal contents are constantly aspirated by an automatic suction device This procedure has greatly improved the prognosis and replaced older and less satisfactory methods such as a jejunostomy operation Both intestinal drainage and intravenous drip may be continued for four or five days, after which intestinal peristalsis returns and an evacuation will occur probably without any other assistance beyond a copious enema

C **Late Cases.**—If this treatment is not proving successful or if the surgeon has not been called in until the disease is far advanced the prognosis is extremely grave and more energetic measures are called for the best of which is Wilkie s technique One cubic centimetre of Prostigmin is given intramuscularly every hour for six hours and after the third and sixth injection a glycerin enema is administered. Should the bowel act at any time the remaining injections are not given The use of ox bile enemata pituitrin and eserine and spinal anæsthesia have little value in this last desperate stage *B welchii* serum has proved to be useless.

Toxic ileus may occur as a terminal manifestation in many toxic states, but is of outstanding importance when associated with an unsuspected failure of renal function. Many patients are referred to a surgeon as cases of acute intestinal obstruction who in reality are suffering from uræmic ileus. This syndrome deserves more attention than it receives and must always be borne in mind whenever cases of obstruction without obvious cause are seen. It is well illustrated by the following case history An elderly man was brought in at the end of an out patient session by his own doctor who had diagnosed acute intestinal obstruction consequent upon a carcinoma of the ascending colon, which could be easily palpated. This swelling was in fact a hydronephrosis of the right kidney and the obstruction was a toxic ileus of uræmic origin the underlying cause being an unrecognised senile hyperplasia of the prostate Correct diagnosis was made upon the patient s general condition the cystic nature of his tumour and complete silence on abdominal auscultation

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MESENTERIC VASCULAR OCCLUSION

Embolism and thrombosis of the superior mesenteric vessels are seen in middle-aged men and women. They may result from endocarditis pyæmia or atheroma or from venous thrombosis in association with portal cirrhosis and peripheral infection. The picture is that of acute intestinal obstruction, but one or more actions of the bowel usually occur and a quantity of blood may be voided The length of bowel involved depends on the site of the vascular lesion, varying from a few inches of ileum to the whole small intestine and ascending colon.

Treatment —Recent observations have shown that operative results with resection of damaged bowel are very poor further unexpected recoveries have ensued in patients given up as hopeless operation risks As a result modern surgical opinion is veering towards expectant—*i e.*, non-operative—treatment

R. M. HANDFIELD-JONES

CHAPTER XXXI

THE RECTUM AND ANAL CANAL

ANATOMY.—The Anal Canal is developed from an invagination of the perineal skin and is lined with squamous or transitional epithelium. It is between ¾ and 1¼ in long. It is surrounded by and closely related to the muscles which control defæcation. These are the external and internal sphincters and the levatores ani.

THE EXTERNAL SPHINCTER has been described by Milligan and Morgan as being composed of three separate parts, viz., subcutaneous, superficial and deep (Fig 333).

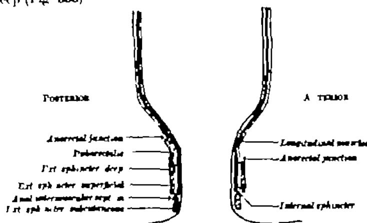


FIG 333

The anatomy of the anal canal as seen in section.

1 *The Subcutaneous Segment* is an annular bundle of muscle fibres surrounding the lower part of the canal. It lies immediately beneath the skin and can be both [illegible] it guarding the anal entrance. By its action the anus [illegible] drawn into several puckered folds. It is not attached to the coccyx but surrounds the anus, the fibres of each side decussating with each other both in front and behind. Its nerve supply is from the inferior hæmorrhoidal nerve derived from third and fourth sacral trunks. This muscle lies on the same plane as the internal sphincter from which it is separated by a well marked ring of fibrous tissue—the anal intermuscular septum, which can be easily palpated.

2 *The Superficial Segment* lies above and outside the former and between it and the deep part of this muscle. It surrounds the lower and middle thirds of the internal sphincter from which it is separated by the downward prolongation of the longitudinal fibres of the rectum. It arises from the coccyx and ano-coccygeal raphe, encircles the bowel and is attached to the central point of the perineum. It is supplied by the perineal branch of the IVth sacral nerve.

the bladder or vagina in the female In the male the fistula must cause a urinary infection and a colostomy should be done in the female, a fistula into the vagina can safely be left, provided the opening is sufficient to allow proper evacuation without obstruction. On the approach of puberty the question of plastic operation or colostomy will need to be considered

INJURIES

The rectum may be injured in a variety of ways (1) in obstetrics when the perineum is torn during delivery or the parts are injured by forceps (2) by falls on spiked objects (3) by the unskilled use of the sigmoidoscope or rectal tubes (4) during operations on the male urethra and prostate and (5) by a variety of instruments used by criminals or lunatics

The *symptoms* are primarily shock, pain and hæmorrhage and later those due to consequent infection of the pelvic and ischiorectal cellular tissues or of the peritoneal cavity

Treatment is directed to an immediate recognition of the extent of the damage An anæsthetic must be given and the rectum carefully examined. Minor tears require nothing but local cleaning and rest in bed with a careful watch for any inflammatory complication. Severe tears will need suturing, and tears into the peritoneal cavity call for laparotomy suture and a temporary colostomy till the rent has healed In all penetrating wounds of the rectum, anti-gas gangrene serum and sulphadiazine should be given.

The rectum may also be injured by foreign bodies which have been swallowed *e.g* tooth plates small bones or pieces of shell or claws of shellfish or again by those formed in the body such as gall-stones or enteroliths Sharp foreign bodies are usually driven into a crypt of Morgagni during defæcation and turn over so that they lie horizontally across the lumen at the anorectal junction The symptoms are typical. During defæcation sudden intolerable pain is experienced in the anal canal, and in spite of complete rest it continues without cessation. Immediate relief follows the removal of the foreign body but careful watch must be kept for five days lest ischiorectal inflammation or a fissure-in-ano result

PROLAPSE OF THE RECTUM

Prolapse of the rectum may be complete or incomplete. Incomplete prolapse is the commoner and consists in the protrusion of a cuff of mucous membrane beyond the anal margin In complete prolapse the whole thickness of the rectal wall protrudes and two degrees are described in the first the peritoneum is unaffected while in the second the lowest part of the pouch of Douglas is drawn down between the prolapsed layers

Prolapse in children is a common occurrence The underlying weakness of the muscles is always an indication of a debilitated condition following illness or malnutrition Accessory factors are those which cause undue straining, such as diarrhœa, constipation thread

worms rectal polypi whooping-cough chronic bronchitis phimosis or vesical calculi.

Prolapse in adults is common in women as a sequel to the weakening of the pelvic muscles during childbirth. In men it is a symptom of local disease *e.g* hæmorrhoids rectal polypi carcinoma of the rectum or enlarged prostate

The *diagnosis* is made by defining the continuity of the prolapsed mucous membrane with the anal skin. The protruding apex of an intussusception or a prolapsed rectal polyp alone can cause confusion.

Treatment should be directed towards the cause Simple local treatment is certain to fail unless the predisposing factor has been removed Small children should be made to pass their motions lying on their side after which the prolapse is replaced and the buttocks firmly strapped together In women whose rectal prolapse is merely a part of a general weakening of the pelvic floor perineorrhaphy and colporrhaphy will cure the rectal condition. In other cases partial prolapse and minor degrees of complete prolapse may be cured by four linear cauterisations of the mucous membrane in its long axis. More severe cases are treated by injection of sodium morrhuate or a solution of quinine into the ischiorectal fossæ and into the hollow of the sacrum Cases with a very patulous anus are treated by a plastic operation upon the external sphincter behind the bowel Finally very advanced examples will require resection of the extruded bowel

INFLAMMATORY DISEASES OF THE RECTUM

Proctitis is due to the same causes as colitis and the two conditions may coexist Catarrhal proctitis is due either to downward spread of a mucous colitis irritation caused by thread worms or bilharzia chronic constipation, injury from scybalous masses foreign bodies or hæmorrhoids It is invariably present in conjunction with carcinoma of the rectum Dysenteric proctitis is secondary to either amœbic or bacillary dysentery in the colon Gonococcal proctitis occurs in women owing to the spread of infection from the vulva and in men from sexual perversions Syphilitic and tuberculous proctitis are ulcerative in type (see below)

The *symptoms* are pain in the perineum and in the pelvis sometimes referred down the thighs tenesmus and mucoid diarrhœa with pruritus or excoriation of the anal skin

Treatment is directed toward the cause Local treatment consists in rest in bed hot hip baths twice daily and irrigation of the rectum with a warm solution of 1 10,000 silver nitrate or of sulphapyridine Very mild aperients such as liquid paraffin, are to be used

FISSURE-IN ANO

Fissure-in Ano is a narrow elongated ulcer at the mucocutaneous junction, lying within the sphere of action of the subcutaneous *segment* of the external sphincter muscle resulting from the tearing of the mucous membrane by a hard fragment of fæces or by a foreign body It is

narrowly triangular in shape, its apex reaching Hilton's line its lower limit the true skin at the anal margin while its long axis is at right angles to the fibres of the external sphincter It usually lies in the middle line of the posterior surface of the anal canal or a little to its right or left Usually superficial it may expose the fibres of the external sphincter in its base

It cannot be seen until the margins of the anal opening are separated when it appears as a purple-coloured ulcer with thin edges and a few weakly granulations Its lower limit is often overlapped by a small fold of torn-down skin known as a sentinel pile It is exquisitely tender and examination is difficult.

Symptoms—Severe pain is experienced when the bowel is emptied, and continues for five to fifteen minutes in early cases but may last for two hours in long-standing ones A little blood and mucus may be noticed.

Treatment is palliative and operative Palliative treatment should be reserved for small recent fissures which have not exposed the fibres of the external sphincter Constipation must be overcome so that a regular soft stool is voided daily At stool wool is used instead of paper and the parts are afterwards washed with soap and water dried and anointed with a mild mercurial ointment

Treatment by injection has become the standard method and rarely fails to bring about healing Gabriel claims that recurrences are probable afterwards but this has not been our experience Ten cubic centimetres of proctocaine are injected in such a way that the tissues immediately subjacent to the fissure are infiltrated and then the posterior third of the circumference of the subcutaneous external sphincter is injected

Operative treatment consists in removing the sentinel pile excising the fissure and dividing the fibres of the muscle at right angles to its long axis so that it is temporarily thrown out of action and the ulcer thus enabled to heal The sphincter may also be paralysed by stretching but this should never be done except by the expert as incontinence has been known to follow overstretching The healing process is accelerated by the use of infra red radiation after operation

ULCERATION OF THE RECTUM

1 **Dysenteric Ulcers.**—In dysentery the mucous membrane becomes congested and œdematous and numerous small ulcers form. These rapidly coalesce to produce a large ulcer with a sinuous margin and smooth floor The condition may lead to perirectal suppuration and ischiorectal abscess and later to stricture

2 **Tuberculous Ulcers** are found usually in the crypts of Morgagni in sufferers from other forms of tuberculosis especially in the lungs The ulcer itself is typical having pale undermined edges and greyish weakly granulations but in the rectum it is surrounded by a ring of unusually firm satellite tubercles which give an induration rarely met with in other tuberculous lesions Ischiorectal abscess and fistulæ are very common sequelæ

3 **Syphilitic Ulcers** are not so frequent as was previously believed and as is still taught by French pathologists The primary chancre is occasionally seen at or just within the anal orifice in both sexes It is a painless indurated ulcer accompanied by painless hard and discrete glands in the inguinal regions Condylomata are a common secondary manifestation. Gummatous ulcers are seen at the anal margin where they present the typical punched-out appearance In the anal canal and lower end of the rectum a massive induration can occur with one or more gummatous ulcers this type tends to stricture formation later

Symptoms—Rectal ulceration occurs after 35 years of age in women more frequently than men The symptoms depend more on the situation of the ulcer than on its cause for all varieties produce a nearly identical picture The higher the ulcer the less is the discomfort Those near the sphincter give severe pain tenesmus diarrhœa and a rapid deterioration of the general health

The patient will first notice that immediately on getting out of bed in the morning there is an urgent desire to empty the bowel but a disappointingly small stool of thin watery mucus is passed without much relief Tenesmus continues and only after several attempts will a satisfactory fæcal stool be evacuated and comparative comfort assured for the rest of the day Later on, as the ulcer extends there will be a constant dull, aching pain, with tenesmus persisting throughout the day The constitutional effects are serious the patient being mentally distressed as well as physically weak.

Treatment—The underlying cause of the ulceration must be energetically treated. Specific treatment if applicable will do more good than local measures which latter are directed chiefly to the relief of symptoms The patient must be put to bed and the action of the bowel regulated so that a soft well formed stool is passed daily Irrigation with warm boracic lotion or with a 1 10 000 silver nitrate solution, brings considerable temporary relief Single ulcers may be scraped or excised after stretching the sphincters but in severe cases a colostomy is required to keep the rectum clean before the ulcer will heal.

A careful watch must be kept for such complications as ischiorectal abscess fistula or stricture.

STRICTURE OF THE RECTUM

Stricture of the rectum is due to cicatricial contraction which may result from any of the following causes —

1 **Congenital.**—These defects have been dealt with (p 673) Congenital narrowing at the level of the cloacal membrane may pass unnoticed until late in life when chronic constipation and difficult defæcation cause patients to seek advice Examination reveals a narrow ring within the anal canal, the margin of which may show one or more fissures.

2. **Inflammatory**—Rectal ulceration due to dysentery tuberculosis, gonorrhœa or syphilis may lead to stricture.

3 **Traumatic.**—Penetrating wounds and operations for prolapse or hæmorrhoids (*e.g* Whitehead's) are sometimes followed by con traction of the scar Those following radium treatment come in this category

4. **Neoplastic.**

5 **Pelvirectal cellulitis** and **abscess** resulting from puerperal sepsis may lead to a horse-shoe arrangement of indurated tissue around the bowel

The stricture is either annular or tubular carcinoma gives a fibrous ring-constriction, while dysentery is followed by tubular thickening over a considerable length of rectal wall. It is more common in women than men and occurs mostly between the ages of twenty five to forty five years The bowel above the stricture is distended and hypertrophied and the mucous membrane is in a state of chronic inflammation with small stercoral ulcers The state of the gut below depends on the site of the obstruction when the stricture is high up the rectum is thin walled atrophic and "ballooned," with internal hæmorrhoids prominent whereas low strictures cause weakening of the sphincters with incontinence and prolapse of mucous membrane

Symptoms—There will be a history of the causative disease High strictures give the picture of chronic intestinal obstruction *i.e.* gradually increasing constipation with alternating attacks of "spurious diarrhœa," the passage of blood and mucus but an absence of pain In the low stricture pain is severe control is lost and blood and mucus escape apart from defæcation, prolapse of the mucous mem brane and internal piles being present If scybalous masses collect above the stricture frequent attacks of diarrhœa occur without affording any relief while later the obstruction may become com plete and the symptoms and signs of acute intestinal obstruction appear

The stricture is easily located by the finger or the protoscope and its nature is determined by its appearance and its history

Treatment—If the causative disease is still active appropriate measures must be directed to it and if the stricture is due to carcinoma radical removal must be advised

The treatment of the fibrous stricture is not satisfactory Gradual dilatation with gum-elastic bougies should be tried first If the stricture yields bougies must be passed and retained in position for five minutes every day for a fortnight and then on alternate days for one month after which once a month for a year should suffice

Internal proctotomy consists of one or more linear incisions into the stricture from inside the rectum This is a dangerous procedure owing to the liability to both intramural and perirectal inflammation. It should be reserved for annular constrictions within 1½ in of the anal opening External proctotomy is a better method and should be used for all tubular strictures the rectum being exposed from behind and the stricture divided completely in the midline posteriorly A certain number of patients will need to have a colostomy performed as the only method of overcoming the obstruction

PERIRECTAL AND PERIANAL ABSCESSES

Abscesses around the rectum and anal margin are of common occurrence in adult life males being affected more frequently than females. The infecting organisms tend to be of low virulence and the pus spreads along the paths of least resistance to reach either skin or mucous membrane so that sinuses or fistulæ are likely to follow The common infecting organisms are *Bacillus coli* staphylococci and streptococci usually in mixed culture and in a certain number of cases tubercle bacilli will also be identified Very rarely gas forming organisms are responsible for a fatal form of perirectal infection.

Perianal Abscess differs in no way from a simple boil and only assumes importance owing to its tendency to burrow and so lead to a superficial sinus or an ischiorectal abscess It follows infection of a hair follicle sebaceous gland or thrombosed external pile an abrasion from riding a horse or a bicycle or from rowing may be a predisposing factor

These abscesses occur at or near the anal margin and give rise to pain and irritation, which are made worse by sitting and walking They appear as small red shiny and fluctuating swellings which are very tender As defæcation is painful the patient is constipated.

Treatment—Early incision is needed to prevent sinus formation and burrowing into the ischiorectal fossa A T-shaped incision is made and the edges trimmed away pus evacuated necrotic debris scraped out and the cavity lightly packed with paraffin and flavine gauze The patient must be kept in bed until healing is well advanced and the period is sensibly shortened by infra-red radiation

Submucous Abscess forms beneath the mucous membrane of the lower part of the rectum and follows trauma by a foreign body or hard fæcal mass or an ulcerating internal pile or polypus Pus forms on one side wall of the rectum and does not spread round the bowel but tracks downwards towards the external sphincter where it will burst through leading to an internal sinus

The patient complains of dull throbbing pain inside the bowel which is greatly aggravated during defæcation, but which is relieved when the abscess bursts It is immediately recognised by a digital examination as a soft fluctuating and tender swelling projecting into the lumen of the bowel.

Treatment—The sphincter must be dilated under general or low sacral anæsthesia and the mucous membrane incised in the whole length of the abscess cavity which is lightly packed with paraffin and flavine gauze The patient must be kept in bed for at least a week and the bowel should not be allowed to act for four days

ISCHIORECTAL ABSCESS

The ischiorectal fossæ lie on either side of the rectum and communicate with each other behind but are separated in front by the genital canal in each sex The boundaries of the fossæ are (1) above and internal—the levator ani muscles (2) below and internal—the external sphincter muscles (3) external—the obturator internus muscle (4) below—the skin of the

anal region (5) above—the junction of the levator ani and obturator internus muscles. At the apex of the fossa in front a small cul-de-sac rests on the triangular ligament (Fig 335)

An Ischiorectal Abscess can be a complication of every type of rectal inflammation and ulceration but the usual form is the result of minor septic conditions in and around the anal canal, *e g* infection of crypts of Morgagni fissures perianal abscesses and hæmorrhoids Organisms are carried to the fossa by the lymphatics and infection soon spreads throughout it owing to the poor resistance of the fat If the abscess is not opened pus tracks behind the rectum and invades the opposite fossa giving rise to the 'horse-shoe abscess' pus also burrows towards the rectum and finding its weakest point—the gap between the internal and external sphincters—bursts through into the bowel In this way a fistulous track is established as soon as the skin is incised or eroded Certain of these abscesses are tuberculous and are slower and more insidious in their onset and progress

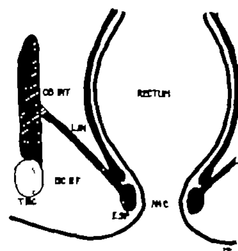


FIG 335

Diagram showing the relations of the ischiorectal fossa. Reference to the text will make the diagram perfectly clear

Symptoms are of acute onset. Pain, which at first is a dull ache, becomes severe and throbbing and is greatly increased by sitting walking and defæcation. So painful and tender do the parts become that the patient cannot find relief in any position A red hot and tender swelling appears in the ischiorectal region and a rectal examination reveals a tender fluctuating mass which does not bulge into the bowel All symptoms disappear when the abscess bursts but as the opening is usually small they return as the pus collects again. Retention of urine is a common complication

Treatment —The danger of a fistula forming is so great that the abscess must be opened with the least possible delay A crucial incision is made and the right-angled corners are snipped away A finger is introduced to break down all loculations and a strip of rubber tissue introduced The patient must be kept in bed till healing is well advanced The cavity is insufflated with sulphanilamide powder and lightly packed daily with paraffin and flavine gauze and irradiated with the infra red lamp The skin must not be allowed to heal until the granulation tissue from the healing cavity is flush with the surface Parenteral penicillin should be given if the organisms are sensitive which is unlikely

Pelvirectal Abscess lies above the levator ani in the connective tissues continuous with those of the pelvic cellular tissue planes. It is not usually the result of rectal disease but follows infections of

the bladder and of the female genital organs (e.g puerperal pelvic cellulitis) Appendix abscesses and diverticulitis may also lead to pelvirectal abscesses

The *symptoms* are those of the causative disease and of the pelvic cellulitis The actual abscess is usually discovered during a rectal examination in these very worrying cases or when it bursts into the rectum In late cases the pus may track and present above Poupart s ligament

Treatment depends upon the cause The abscess should be opened either through the rectal wall or in women through the posterior fornix of the vagina In spite of the gravity of the illness it is wise to wait for a localised collection to form before operating

SINUS AND FISTULA IN ANO

The imperfect drainage of perianal and perirectal abscesses will lead to the formation of tracks lined by pyogenic granulation tissue Healing is prevented by the constant muscular movement in this region and if the track communicates with the bowel a permanent source of reinfection is established The term *fistula* denotes a track opening at one end on the skin and at the other on the mucous membrane Those tracks which open at one end only are *sinuses* and the old term of blind fistulæ will be discarded

An External Sinus follows a perianal or ischiorectal abscess which has been opened on the surface and which has failed to heal A small opening can be seen and pus may be expressed from it It is by no means common

An Internal Sinus follows a submucous abscess and is still less common It can be identified as a narrow elongated area of induration in the rectal wall with an opening at its lower margin from which pus can be seen oozing

Fistula-in Ano is more common than it should be It results from ischiorectal or pelvirectal suppuration The opening into the bowel may have occurred before the patient seeks advice and the skin incision into a supposed simple ischiorectal abscess merely completes the fistula which may only be discovered later when the wound refuses to heal. The etiology is precisely similar to that of perirectal inflammation and men are much more frequently affected than women The possibility of the infection being tuberculous must always be borne in mind.

The track may take a direct line from the bowel to the skin, or it may be tortuous or even branched A well recognised example of the complicated variety is the *horse-shoe fistula* in which the track passes round the rectum behind from one fossa to the other the external opening being on the opposite side to that into the rectum. Three types of fistula are described (A) the submuscular or sub cutaneous fistula runs from skin to anal mucosa and is below *the level* of the external sphincter (B) the intermuscular fistula is the commonest of all the track reaching the rectum between the internal and external sphincters (C) the supramuscular—the rarest and most serious—

enters the rectum high up above the levator ani through which the track passes (Fig 336)

The *symptoms* are discomfort due to the leakage of pus and fæcal stained mucus and intermittent attacks of pain and tenesmus when pus collects under tension

Treatment consists in a complete opening up of the track in the whole of its extent together with any ramifications When it is a simple direct tunnel a malleable probe-pointed director is passed up it and made to project into the rectum the point then being brought out of the anal orifice The director is carefully arranged so that it passes exactly at right angles to the long axis of the fibres of the external sphincter and the track is laid completely open The walls are curetted with a sharp spoon, or if very indurated are excised, and the wound is packed with paraffin and flavine gauze and compelled to heal from the bottom.

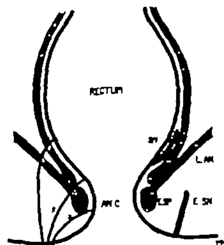


Fig 336

Diagram illustrating on the right side an internal and an external sinus (I.S. and E.S.) on the left side the three types of fistula-in-ano, indicated by the figures 1 2, 3.

Horse-shoe fistulæ are more difficult to deal with, but the same general principles apply The external sphincter is divided at the point where the track passes over it to enter the rectum It should be divided only in one place and never under any circumstances in more than two

The supramuscular fistula which traverses the levator ani, cannot be treated in a similar manner because incontinence inevitably follows the division of both sphincters and part of the levator ani A two-stage operation is performed the upper part of the track above the levator ani being opened scraped and plugged and at a later date the track below the levator is laid open. The prognosis in these cases is not good

In all cases healing can be obtained and recurrences prevented only by the most rigorous after treatment in which the dressings are painful and tedious and may easily be done inefficiently Every day and after each motion the wound is cleansed and packed with gauze soaked in paraffin and flavine or red lotion The bowel must be confined for four days after operation, when a soft formed stool must be arranged for by suitable aperients Patients must be kept in bed until healing is complete This may be greatly accelerated by the use of the infra-red lamp

Complete excision with suture can be used in simple direct fistulæ and in many cases of tuberculous infection

Fistulæ into other Organs.—Communication between the rectum and bladder vagina male urethra Fallopian tubes and appendix may follow infection or malignant new growth of these structures

Treatment is directed towards the cause and a colostomy may have to be considered

HÆMORRHOIDS

Internal Piles.—The lower end of the rectum is one of the chief sites of venous anastomosis between the portal and systemic circulations The superior hæmorrhoidal veins which are devoid of valves pass into the portal system whereas the middle and inferior hæmorrhoidal veins join the systemic circulation. This anastomosis under certain conditions becomes the seat of varicose dilatation, in this way establishing the condition known as internal hæmorrhoids or piles

Each internal pile therefore consists of a nodule of varicose veins and one of the terminal branches of the superior hæmorrhoidal artery which are surrounded by a sparse amount of connective tissue and covered by rectal mucous membrane One internal pile or more may be present but in well-established cases three major piles will always be found one situated anteriorly and the other two postero-laterally Internal piles cannot be felt with any certainty on digital examination but are seen through the proctoscope as purple projections from the lower rectal wall which grow steadily larger and more engorged for the first few moments after the speculum is introduced

Internal piles are seen in both sexes between the ages of twenty and sixty five years and are due to many causes which may be classed in four groups

1 Idiopathic hæmorrhoids occur in people with no local or general disease and are due to a familial predisposition, as are other forms of varicose veins

2 Constipation is the commonest cause owing to the pressure of inspissated fæcal masses on the valveless veins

3 Straining due to enlarged prostate urethral stricture etc.

4 Back pressure in the veins *e.g* (*a*) in the rectal wall by carcinoma of the rectum inflammatory and ulcerative diseases and strictures (*b*) in the portal vein from cirrhosis of the liver heart disease and splenomegaly (*c*) in pelvic congestion from the gravid uterus, uterine and ovarian tumours and diverticulitis

The complications to which internal piles are liable are thrombosis phlebitis periphlebitis ulceration and strangulation.

Symptoms—These are hæmorrhage mucous discharge prolapse and pain

Piles of the First Degree do not come outside the sphincters These will cause the appearance of a few drops of fresh blood with the passage of each motion There are no other symptoms and if the motions are kept soft and regular there may even be little or no bleeding

Piles of the Second Degree come down with each act of defæcation but return spontaneously or can be easily replaced by the patient. In this stage the piles are well formed polypoid tumours with a broad base and bleeding becomes a prominent symptom. When the piles have come out their bases are gripped by the external sphincter and intense venous congestion results As long as they remain out venous

blood steadily oozes from them, but the bleeding ceases as soon as they are returned into the rectum If the surface is ulcerated bright arterial bleeding may be detected and this tends to continue for a time after the piles have been replaced in which case blood collects and will be passed later either alone or with a fæcal motion The hæmorrhage in second degree piles is often sufficient to cause a marked degree of secondary anæmia. Moderate pain or discomfort is present and some mucus will be passed

Piles of the Third Degree are combined with a lax sphincter and a state of chronic partial prolapse is found. As a result of constant irritation and infection the mucous membrane covering the piles is converted into transitional or squamous epithelium Bleeding is trivial or non-existent but the mucous discharge is profuse and leads to irritation and pruritus ani. Pain both locally and in the back is pronounced and patients suffer considerable mental distress and will spend much time daily in a futile effort to replace the prolapsed piles.

Treatment.—No treatment should be considered until it has been proved that the piles are idiopathic and are not due to any local or general disease It cannot be emphasised too strongly that internal hæmorrhoids are frequently not a disease but merely a symptom of other pathological lesions There can be no excuse for the treatment of hæmorrhoids while an operable carcinoma of the rectum passes unnoticed.

General Treatment.—If the cause can be effectively treated the piles will disappear in due course In pregnancy piles give trouble in the earlier and the later months but no treatment should be advised, unless they are causing secondary anæmia in cirrhosis of the liver and in other causes of portal obstruction, local treatment may be undertaken if the piles are causing real distress but the patient must be told that the relief is temporary and that recurrence is to be expected within six months

Constipation will need attention in every case The weakest dose of a mild aperient which effects a result should be aimed at good examples being liquid paraffin phenolphthalein senna or one of the preparations of biliary and intestinal extracts such as eulaxase or taxol. A careful regulation of the diet will also tend towards a satisfactory result.

Local Treatment.—*A* **Palliative**.—Mild first degree piles may need no attention beyond regulation of the bowels and the use of suppositories or ointments containing an astringent such as witch hazel

B **Injection**.—Other piles of the first and second degrees should be treated by injection. This method has great advantages being reliable and safe in careful hands needing no anæsthetic and producing little or no pain Further it can be done in the consulting room with no loss of time from work for the patient A special syringe with a long narrow barrel a grooved speculum and a good headlamp are required The sclerosing fluid is injected into the base of the pile and not into its most prominent part and great care must be taken to ensure that the needle is introduced into the rectal mucous

membrane and not into the anal skin The following preparations are suitable for the purpose —

R	Ac carbolici	ℨi
	Zinci chlor	gr i
	Ol olivæ	ℨv

5 to 8 minims into each pile

or

R	Sodii biboratis	℥i
	Ac salicyl	ℨL
	Glycerini	℥i
	Ac carbolici	ℨiij

5 to 8 minims into each pile

At the first treatment it is wise to inject one pile only and to observe the reaction On subsequent occasions two may be safely injected unless the patient has had a marked reaction to the first injection. The contraindications to injection are thrombosis ulceration and strangulation. The method must never be used for external piles

C **Operative** —Operation is needed in those cases which are not suitable for injection Piles of the third degree are associated with a patulous sphincter and should be operated upon The method generally practised in this country is that of ligature and excision The three main piles are removed with the redundant folds of anal skin no attempt being made to remove any lesser pile lest a fibrous stricture follow

Complications are strangulation, thrombosis and ulceration.

1 Strangulation. A patient who has hitherto been able to replace the prolapsed piles after each motion, finds that the mass cannot be pushed back. The use of lubricants and the prone position fail to bring about reduction and the feeling of congestion and discomfort rapidly passes into severe pain from which no relief is obtainable Examination reveals a violet mass of intensely congested and swollen piles firmly gripped above by the sphincter and projecting beyond the anal margin Gangrene may follow in some cases

Treatment —The patient must be put to bed the end of which is raised on blocks and hot compresses applied to the prolapsed mass. An injection of morphia and atropine is given. Within four hours an attempt is made to replace the piles In a small number of cases this can be done without an anæsthetic but the pain tenderness and spasm are so great that a general anæsthetic is usually necessary The prolapsed mass is replaced and the sphincter stretched The patient is kept in bed till all swelling has subsided, after which removal of the piles should be advised

2 Thrombosis An internal pile can become inflamed as the result of phlebitis and periphlebitis Patients complain of pain, tenesmus a mucous discharge and some œdema of the anal margin The condition lasts a few days and is usually followed by a general improvement, as the affected pile will shrink up as the thrombus organises

3 Ulceration Strangulated and thrombosed piles may become ulcerated when pain and tenesmus are more prolonged than in simple

thrombosis Patients should be kept in bed the bowels carefully regulated and suitable suppositories or ointment applied locally An excellent ointment consists of

℞	Ung ac. tannici	āā ℥i.
	Ung stramonii	
	Ung belladonnæ	

External Piles.—A TRUE EXTERNAL PILE consists of a varicose perianal vein contained in a redundant fold of skin. This may be present independently of or coexist with internal piles It gives rise to no symptoms until it becomes thrombosed when the vein ruptures as the result of some severe strain and a clot forms in the fold of skin. This thrombosed external pile presents at the anal margin as a tense spherical, dark blue swelling which is so exquisitely painful and tender that the patient can find no relief

Treatment is incision under a local anæsthetic the clot being shelled out Healing is rapid.

A FALSE EXTERNAL PILE consists of a redundant fold of skin without any venous component. Several of these tags may be present, and give no symptoms except a little local irritation

Pruritus Ani.—Pruritus ani is a condition of itching of the skin surrounding the anus and in women is confluent with pruritus vulvæ The itching may become so intense that the patient s life is made an almost intolerable burden and the general health suffers from constant irritation and sleeplessness It is always worse at night and in hot weather but in later stages is constantly present. Although it may be an indication of general disease *e.g* gout or diabetes it is usually a symptom of rectal disease and no case must be diagnosed as idiopathic until a complete examination has proved the rectum normal In children intense itching may be caused by thread worms.

In early stages the skin is dry wrinkled and powdery white in colour but in many cases patients have scratched themselves so vigorously that œdema and surface ulceration are present Treatment is directed to the cause and if none is found the condition is likely to be very intractable X ray therapy often achieves a cure and the following ointment is of value —

℞	Menthol	gr xv
	Plumb acet	gr v
	Calomel	gr iii.
	Paraff molle	ad ℥i

Gabriel advises extensive subcutaneous injections of proctocaine all round the anal region especially posteriorly and in some cases removal of wide areas of perianal skin

NEW GROWTHS OF THE RECTUM

The growths of the rectum are —

Benign—
 Epithelial—adenoma.
 Connective tissue—fibroma, lipoma hæmangioma
 Foreign body reaction— paraffin granuloma

Malignant—
Carcinoma and sarcoma.
Carcinoma of the anal margin

Adenoma.—The benign tumours of which adenoma is by far the most common are frequently referred to as rectal polypi and this term includes any of those growths which have a pedicle and are covered with epithelium (Fig 337)

The adenoma occurs at any age but is especially frequent in children under twelve It is composed of glandular acini lined with



Fig. 337
Microscopic drawing of an adenomatous polyp. The high columnar epithelium with goblet cells is well shown.

columnar epithelium and its surface is either smooth, fissured or deeply furrowed. As it increases in size its pedicle becomes longer and narrower until although its point of attachment is several inches up the rectal wall, the tumour may project through the anal opening Viewed through a speculum it appears as a soft red mass projecting into the lumen of the rectum.

Multiple adenomata are sometimes seen in the form of soft reddish growths with a fissured, warty surface, either scattered diffusely over the rectal mucous membrane or covering large confluent areas They are called diffuse papillomatous adenomata It is probable that such a condition must be regarded as precancerous

Some hypertrophic adenomatous conditions in the rectal mucosa are not truly neoplastic but are due to chronic irritation or infection, an example of which is that caused by rectal bilharzia

pain from nerve involvement may be very severe and it may be for sciatica" that the patient first seeks advice

5 Hæmorrhoids are so common a concomitant of rectal carcinoma that their presence should serve immediately to direct attention to the possibility of a malignant growth

These symptoms occur in varying degrees of intensity in all cases and it must be borne in mind that sooner or later in every case infection occurs and proctitis and periproctitis add their quota to the picture Rectal carcinoma has no specific syndrome but presents a story of chronic intestinal obstruction, of rectal ulceration or of a combination of the two In any case the history should not fail to lead to an immediate and exhaustive examination of the rectum and colon.

Examination —A digital examination will either reveal stenosis of the bowel or palpate the hard edges of an ulcer or a fungating polypoid mass with an indurated base If nothing abnormal is found, a sigmoidoscopy and barium enema examination should be performed

Diagnosis —The obstructive group will need to be distinguished from the many causes of chronic intestinal obstruction while those with pain, tenesmus and passage of blood and mucus must be differentiated from diseases which produce rectal ulceration.

Treatment —Whereas it will be evident in certain cases from a digital examination that the growth is inoperable it is not possible to decide that the tumour is suitable for removal on a rectal examination alone It is not until the abdomen has been opened that the surgeon can examine the growth from above and explore the abdominal contents for secondary deposits Enlarged lymph glands in the hollow of the sacrum are not a contraindication to operation but fixation of the growth to the sacrum prostate or bladder invasion of the peritoneum or of the pelvic floor involvement of the lumbar lymphatic glands or of the liver render any radical operation unjustifiable

Operable growths are dealt with by excision of the rectum the methods of performing which are described on p 694

The treatment of inoperable growths is a matter of controversy If there is a definite stenosis a colostomy must be performed to avoid the possibility of obstruction becoming acute but in those growths without stenosis the value of the colostomy is open to question and many surgeons advise strongly against it It does however prevent the passage of fæces over the growth and allows the inflammation of the bowel above and around the tumour to subside As a result some patients show a marked improvement in their general health, due to the lessening of toxæmia the relief fr must be judged strictly c s and th Each case be the relative comf rt of with or w factor will Radium therapy in some es cons colostomy only temporarily even if

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trained and managed colostomy needs attention in the morning only and places no restraint on the patient s activities

Education begins on the 12th day after operation when the bowel is firmly fixed and the skin incision healed. In the morning the colon should be completely emptied and washed out A soft rubber catheter is passed well up into the colon and a pint of warm water is slowly run in within a minute a profuse action occurs and about twenty *minutes* later a second smaller one follows These are passed into a bowl or directly into the lavatory by means of the St Thomas Hospital colostomy horn (Fig 340) which is strapped in position by a belt around the waist The opening is then gently cleaned dried and powdered and as soon as the patient gets up a special belt *e.g* the

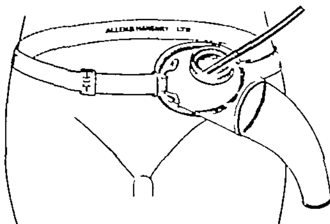


FIG. 340

The colostomy horn shown in situ with the rubber catheter entering the upper segment of the bowel for irrigation. (*Allen & Hanburys.*)

"Agordian" belt is worn, in which no cup and no perineal straps are required An occasional accident will occur at first but within six weeks the bowel should be trained to perfect behaviour Attention to diet will be important and individual patients will learn by experience what foodstuffs and fluids must be avoided Colostomy patients are compelled to spend between thirty and forty minutes each morning in attention to their bowel action, but apart from this they should be in no way handicapped or distressed

Sarcoma is a very rare growth in the rectum being seen in children or in adults past 40 years of age It is a tumour of the submucous tissue and grows inwards towards the lumen, thus producing single or multiple rounded swellings Red soft masses will be seen through the proctoscope and invasion of the muscle coats occurs Metastasis is widespread and early

The *symptoms* are pain, discharge of blood and mucus and tenesmus
Treatment is rarely practicable

Carcinoma of the Anal Margin is a squamous-celled carcinoma which takes the form either of a warty tumour or of a typical ulcer The growth is usually slow and enlargement of the inguinal group of

lymph glands will be the first sign of metastasis The appearance of the growth is so typical that it is unlikely to cause difficulty in diagnosis, tuberculous and syphilitic lesions being possible alternatives.

Treatment is by excision, and as this will usually need to include the sphincters a colostomy is a necessary preliminary The inguinal glands should also be removed. Deep X ray therapy should be employed for inoperable cases

R. M. HANDFIELD-JONES.

OPERATIONS ON RECTUM AND ANUS

A **For Fissure-in-Ano.**—Patient in lithotomy position After gentle dilatation of the anus so exposing the full extent of the fissure this is incised throughout its length and the indurated edges and base removed complete either with a knife or by curetting with a sharp spoon. If a sentinel pile is present this is also removed

B **For Fistula.**—Patient in lithotomy position. After anal dilatation the extent of the fistula is investigated with a probe-pointed director down which a knife is run to lay the track wide open. In complete fistulæ this may involve cutting the external sphincter This should be done at one place only and at right-angles to the direction of the fibres Under no circumstances should both sphincters be cut Where the inner end of the fistula opens above or passes above the internal sphincter the track is laid open up to this level and the remainder of the fistula cauterised either chemically or with the diathermy

C **For Hæmorrhoids.**—(i) *External* —An incision is made directly over the thrombosed vein and the clot is turned out.

(ii) *Internal* —Patient in lithotomy position. The anus is gently dilated and each hæmorrhoid (there are usually three major protrusions often with satellite piles on either side) is drawn down by a pair of Kocher's forceps and a V-shaped incision made with scissors on the outer (skin) aspect of the mass From this point by blunt or gauze dissection the pile is gradually freed until its base can be clamped transversely with another pair of Kocher's forceps The redundant mucous membrane and skin distal to these forceps is then cut away and with the clamp still *in situ* a transfixion suture of strong catgut or silk passed through the base which is then doubly tied as the forceps are released The ends of these ligatures are frequently left long—protruding through the anus.

D **For Carcinoma Recti.**—A variety of operations are available and in use *for this condition—the method employed in any particular case depending* on the type of growth its level in the bowel, its operability (*i.e* fixation to surrounding structures and presence of secondaries—local or hepatic) and the patient's general condition. The essential object of the operation is to remove the growth with its immediate lymphatic drainage—as in other malignant neoplasms As a preliminary in all cases a laparotomy will confirm clinical findings, demonstrate the presence or otherwise of local secondary deposits (which do not necessarily vitiate operation) and allow exploration of the liver for possible hepatic metastases

I For inoperable cases a left iliac colostomy is performed where obstructive symptoms are predominant and in an attempt to rid the actual growth of the constant irritation and infection resulting from the passage of fæces With this may be combined a purely palliative removal of the growth from a perineal approach to prevent the pain bleeding and mucous discharge of an ulcerating or fungating carcinoma.

2. For operable growths the following methods are available —

(a) *Abdomino-perineal Resection* —A laparotomy is first performed and the pelvic colon divided distal to the first major branch of the sigmoid artery The proximal portion of the pelvic colon is brought out through a separate incision to form a permanent colostomy (This may be done as a separate operation.) The distal portion and mesocolon are then dissected down to the sacral promontory the pelvic floor is opened and the dissected colon mesocolon and connective tissue with glands tucked down into the space above the levatores ani Care must be taken not to injure the left ureter The pelvic floor is then reconstructed and the peritoneum closed The patient is gently turned over into the left lateral position, the anus sewn up and through a racket-shaped incision (the "handle" of which allows removal of the coccyx) the anal canal and lower rectum dissected up until cutting of the levatores ani allows delivery of the previously freed pelvic colon. The resulting space is packed with gauze and the wound partially closed over this

(b) *Perineal* —With the patient in the lithotomy or left lateral position the operation is carried out as in the second stage of the abdomino-perineal resection until the pelvic floor is reached. The peritoneum is opened and the colon drawn down as far as possible cut across and the proximal end carefully closed with invaginating sutures This stump can be covered with peritoneum as the pelvic floor is reconstructed. The resultant cavity is packed and closed as before

This operation is used for growths low in the anorectal canal in patients whose general condition would not stand the more radical procedure It is unsatisfactory in that it does not allow full removal of the area of lymphatic drainage nor an examination of the liver

(c) *Combined Synchronous Perineo-abdominal Resection* —In this operation two surgeons work concurrently with the patient in a combined lithotomy Trendelenburg position Junction is effected at the level of the pelvic floor and the whole length of freed gut from anus (protected by a surrounding rubber glove) to upper third of pelvic colon drawn up into the abdomen and brought out through a separate incision in the left iliac fossa. Not until the pelvic floor has been reconstructed the abdomen closed and the perineal wound packed is the dissected length of gut removed outside the abdominal wall—thus making the procedure practically aseptic The combined method though still productive of considerable shock, affords a great saving in time

(d) *Anastomotic Methods* —There is no doubt that such methods provide the ideal solution for these cases—many of which would rather perish from their growths than face life with an abdominal artificial anus The anastomosis can be effected either through the abdomen or through a posterior perineal incision with removal of the coccyx In the latter case no peritoneal covering is available for the intestinal suture lines, and some degree of infection and leakage is almost inevitable A later tendency to stricture has also to be carefully watched for The great drawback to all such methods is that they seldom afford an opportunity for really radical surgical removal of the growth and its lymphatic drainage areas In certain carefully chosen growths—usually early and freely mobile without obviously palpable local metastases—they have given very satisfactory results.

A E PORRITT

CHAPTER XXXII

THE DISEASES OF THE APPENDIX

SURGICAL ANATOMY.—The vermiform process or appendix is a narrow tube opening at one end into the cæcum and being closed at the other. Its length varies from 2 to 20 cm., the average being 9 cm.; its thickness in the normal state from 3 to 7 mm. The natural contents are mucus and the small quantity of liquid fæces that enters it from the cæcum. The wall of the organ is similar to that of the colon, being composed of like elements. The *serous coat* is usually complete except at the attachment of the meso-appendix, but the normal peritoneal relations vary greatly and any part or whole of the organ may lie extraperitoneally. The *muscular coat* has an outer layer of longitudinal fibres, continuation of the assembled tæniæ coli, and an inner circular one; these together forming a complete investment except in some appendices, in which muscular defects leave serous and mucous coats in contact. The *submucous coat* is thick and consists of an uninterrupted layer of lymphoid tissue disposed in nodules, which throw the mucous layer into irregular folds. The *mucous lining* resembles that of the colon, being a mucus-secreting columnar epithelium. At the cæcal orifice there is sometimes a semilunar fold that has the appearance of a valve guarding the opening.

Peritoneum, Blood Supply and Lymph Drainage.—The meso-appendix is a small triangular fold passing from nearly the whole length of the organ to the postero-inferior aspect of the cæcum and to the lowest part of the left leaf of the mesentery. In its free border runs the appendicular artery, accompanied by the vein, passing behind the ileum as it runs from the ileocæcal artery to reach the meso-appendix. Passing from the front of the meso-appendix to the cæcum is the inconstant inferior ileocolic fold, forming when present the anterior wall of the internal ileocolic fossa, a small pyramidal cavity bounded by the ileum above and open to the left. This fold is sometimes named the "Bloodless Fold of Treves," inappropriately since it usually bleeds when cut. The *lymph drainage* of the appendix passes by channels accompanying the blood vessels to the ileocæcal glands that drain the lower end of the ileum and the cæcum. Sometimes the appendicular lymphatics are interrupted by lymph nodes in the base of the meso-appendix. From the ileocæcal glands the efferents pass upwards to the lymphatic plexus near the head of the pancreas, where there is an intercommunication between the channels from the appendix, duodenum, biliary apparatus and pancreas.

Anatomical Variations.—There are many variations in site and disposition of the appendix, as also in the conformation of the adjacent cæcum. Thus its orifice may be so close to the ileocæcal valve that its base is in contact with the ileum as it turns upwards in approaching its termination, there may be a small pouch of cæcum between the appendix and the valve, or the appendix may form an axially placed prolongation arising on a conical base from the mid point of the cæcal apex. The length of the appendix may be several times that of the base of the meso-appendix, in which case the

organ is apt to be bent or coiled, such normal flexures being at times responsible for obstruction to the lumen or constituting factors in the precipitation of inflammatory disease

Its position may be such that it points *upwards and to the right* behind the cæcum *upwards and to the left* behind or less commonly in front of the lower ileum *downwards and to the right* in the iliac fossa or *downwards and to the left* so that it lies wholly or partly in the pelvis. This pelvic position is of clinical importance the organ may pass over the pelvic brim from an iliac cæcum or lie wholly in the pelvic cavity if the cæcum is there also The position of the appendix naturally depends upon the many anatomical variations of the cæcum and on the extent of the developmental rotation of the gut around the superior mesenteric artery Thus it is not unusual for the cæcum and the appendix to lie in contact with the under surface of the liver or in any site between this position and the pouch of Douglas The cæcum may be congenitally large or distended by disease so that the base of the appendix is carried downwards unless it is fixed in an extraperitoneal situation in the iliac fossa, when the cæcum becomes folded backwards on itself All the above positions should be borne in mind when disease of the organ is in question, and it is important to remember that about one fifth of all appendices are pelvic in position



FIG. 341

X-ray showing large appendicular stercolith, lying free in the peritoneal cavity after the rupture of gangrenous appendix.

Finally the appendix may occupy a small peritoneal pouch, retrocæcal or ileocæcal, the inconspicuous entrance to which may necessitate a little dissection before its display is possible

Surface Marking —From the foregoing considerations it is obvious that no surface marking can indicate the position of the appendix in any but too vague a way for surgical approach nevertheless its origin in the cæcum in many cases underlies MacBurney's point i.e., the junction of the middle and lateral thirds of the right spino-umbilical line

Function of the Appendix —Like the colon, the appendix absorbs water from its contents and, though the quantity is inconsiderable no other function is known in man. In disease the water-absorbing function is nevertheless important because it often results in solidification of the contents with partial or complete obstruction of its lumen. Contraction of the appendix may be seen in radiographic examinations but where obstruction of the lumen exists peristalsis may be incompetent to expel the contents into the cæcum when continued dehydration results in the formation of small sessile masses named stercoliths (Fig 341) *Foreign bodies* do not easily enter the appendix unless small or having a motility of their own thus the only ones found at all commonly are small shot seasonally in the game-eating classes and usually passed spontaneously and threadworms which the appendix harbours with the rest of the colon in afflicted persons

APPENDICITIS

By appendicitis is meant an acute or chronic inflammation of the organ

Etiology

A **Racial.**—Inflammation of the appendix seems to be a disease of modern western civilisation and is found especially in peoples whose nutritional habit is the large consumption of cooked protein food but of relatively little cellulose Even in such races there are groups where the incidence of the disease is low of which the recognised examples are the inmates of institutions providing for reasons of economy low protein dietary and greater preponderance of cellulose-containing foods Thus prisoners lunatics orphans and others cared for by Poor Law and some charitable authorities have been instanced as rarely suffering from it The example of lunatics is noteworthy in connection with the fondness of many of them for swallowing indigestible objects because small ingested foreign bodies were at one time thought easily to enter the appendix and so to produce disease It must be remembered that the refinements of *diagnosis in appendicitis are at the present time so efficient that it may* be recognised in all its grades from slight congestion to gangrene and that whereas serious appendicitis is diagnosed straight away the minor examples that focus the attention of the private practitioner and constitute the greater proportion of the incidence among his patients are less likely to be brought to the notice of the medical attendant in institutional than in private practice. This is certainly the fact among the mentally afflicted, because they can often give no account of their troubles and the diagnosis must be made on physical signs alone Nevertheless there seems to be little doubt that in Eastern Europe and Asia, where among the country folk the dietaries contain minimal animal protein or none appendicitis is uncommon, but when the same people give up their natural frugality with emigration or increasing domestic prosperity the incidence rises to that prevailing among their new associates A possible explanation of these facts is that the rich cooked food of western civilisation fails to stimulate the colon to its healthy motor activities the appendix thus failing to *discharge its contents which when solidified become a possible cause* of obstruction to its lumen Appendicular obstruction is nevertheless only one cause of inflammation and is probably not the sole determining factor in the racial incidence

B **Age.**—Appendicitis is rare before the age of three years but it may be seen in infancy sometimes with the slightest of physical signs so that to deny the probability of its existence in a sick baby is a reprehensibly dangerous attitude It is also said to be rare in old age but the old are certainly not exempt merely less commonly affected than young Appendicitis becomes common after the age of three years perhaps because the character of the child's diet begins then to approach that of his civilised parent and its frequency then increases rapidly until the age of ten years when it remains an

extremely common disease until the onset of old age It is said that the end of adolescence coincides with the peak of the incidence

C **Sex.**—Unlike constipation which we are accustomed to assign to a like etiology appendicitis is about twice as common in men as in women

All these generalisations are interesting facts but none of them should be uppermost in the practitioner's mind when attempting diagnosis in an acute abdominal condition

Pathology

Acute appendicitis is due to the entrance of micro-organisms into the wall the principal germs being the colon bacillus and the streptococcus in any of its breeds Anaerobes are met with also and may be responsible for the offensive smell of pus from appendicular abscesses but they are often saprophytic secondary growths in the exudate rather than pathogenic organisms thus a patient in whose abdomen there exists a large abscess containing unpleasantly offensive pus, may suffer a relatively slight toxæmia Organisms may arrive in the appendicular wall by the two routes of direct spread from the contents or from the blood stream Evidence of the existence of *hæmatogenous infections* is mostly clinical and rarely confirmed by culture being found for example in the sequence of appendicitis following quickly in the trail of upper respiratory infections so that when influenzal attacks are epidemic so also it may be said is acute appendicitis Such respiratory infections appear primarily in the lymphoid tissues of the pharynx, and when appendicular metastasis occurs the lymphoid nodules of the submucosa are the sites selected. There are also the much rarer cases in which similarly inflamed appendices occur as incidents in declared septicæmia. *Infection of the appendix from its contents* also affects the lymphoid tissue though its primary cause is in a large number of cases of an obstructive nature such as any of the following (*a*) there may be a stercolith in the lumen which prevents evacuation of mucus or much more rarely a foreign body (*b*) there may be a sharp bend in the appendix due to the conformation of the peritoneal folds and if the distal part becomes distended such a bend may become an impassable kink with resulting complete obstruction. With stagnation of the contents and increasing distension of the organ, the contained mucus becomes highly infected and the starting point of inflammation (*c*) earlier attacks of inflammation may have produced scarring constricting the lumen

In typical examples these two modes of infection result in distinct morbid appearances In blood-stream infections the whole length of the appendix is commonly swollen or if part only the affected portion fades into the normal without sharp dividing lines. The wall is thickened by œdema and exudate is seen on the surface the organ is turgid and no longer flexible or contractile, yet the mucosa may be little affected in an early case and the contents neither increased nor greatly altered in character As the disease progresses the mucosa may become as

intensely inflamed as the other coats so that the condition of the appendix now becomes indistinguishable from one due to the other type of infection i.e. that coming from the lumen. Such acute blood borne infections vary in gravity from the mild to the intensely toxic and are often streptococcal As a sub-group of this variety are those uncommon cases in which a streptococcal septicæmia settles down in the appendix, the appendicitis then having much the same relation to the generalised infection as has a pyemic or what is called a "fixation" abscess Hæmatogenous infection of the appendix may proceed from inflammation to gangrene necrosis appearing first in the mucosa after the contents have become severely infected but until this happens the liability to perforation is slight Nevertheless peritonitis is common in the absence of perforation which is not surprising since an inflammation of the substance of the wall may reach the peritoneum before affecting the mucosa In the blood borne group there should probably be included those septicæmic cases where there is an associated phlebitis spreading from the appendicular vein to the ileocolic and possibly *even to the superior* mesenteric vein.

Appendicitis due to infection from the contents is often, but not necessarily the result of obstruction to normal evacuation which indeed if not the activating cause may prove a potent factor in determining the evolution of the disease In a typical obstructive case there is a kink proximal to which, if the obstruction is away from the base the appendix is normal at the onset and only later affected by spread of inflammation in the wall. The mucosa rapidly becomes *congested*, then hæmorrhagic and at length *gangrenous* The organ distends and its wall becomes *secondarily infected* so that at one stage the mucosa may be on the verge of gangrene but the muscular and serous coats are hardly affected With the progress of the disease all the coats are inevitably inflamed and unless subsidence occurs gangrene of the wall initiates perforation with escape of highly infected contents Such a perforation may occur anywhere but is most typically seen at a point where pressure of a stercolith has precipitated infective gangrene of the mucosa It is a curiosity of morbid anatomy that the tip of the appendix habitually escapes until a late stage, though it might have been expected that distension would early cut off the blood supply to the distal extremity The consequences of perforation are noticed in relation to the effects on the peritoneum (see p 503) nevertheless a common site for perforation is the attachment of the meso-appendix *in which an abscess then develops often causing* localised thrombosis of the appendicular venules In obstructive appendicitis when such changes occur but stop short of perforation and then subside scarring of the appendix will result the consequences of which will be described among the effects of chronic appendicitis.

The Effects of Appendicitis on the Peritoneum

Inflammation of the appendix affecting the serous coat causes local peritonitis, having the usual characters of fibrinous exudate and fluid

effusion The character and progress of the peritonitis depend upon the nature of the organism and the route by which infection reaches the serous membrane Thus sometimes there is little fibrin and consequently little localisation of the inflammation by adhesive peritonitis such infections being often streptococcal in origin. Though many are of the severest and most dangerous types others are mild infections which patients are easily able to overcome At other times there may be a fibrinous exudate that completely seals the infected area and again many of these are trivial while others are of the greatest severity In the former cases the sealing process rapidly brings an end to the spread of the disease and with the subsidence of the appendicular infection the patient effects a speedy natural cure In the latter it may be that the localisation of the disease by fibrin results in the walling-off of an *abscess* which once formed may behave in several ways Thus it may be completely absorbed, it may grow to an enormous size as a localised abscess the remainder of the peritoneum being unaffected or it may rupture either into the peritoneal cavity, into a hollow viscus or on to the surface In the peritoneal rupture reinfection of the cavity with a new and diffuse peritonitis results Between the two extremes of watertight sealing and complete failure to localise there are numerous cases of partial sealing in which the degree of adhesive peritonitis is insufficient to prevent diffusion, and in which as a consequence a partially localised abscess occupies the centre of a diffusing peritonitis These cases may end either in final complete localisation followed by absorption and recovery or in progressive diffuse peritonitis with all its attendant horrors It follows from what has been said that if a distended inflamed appendix bursts when adhesions to its serous surface are already well formed a localised abscess is the likely consequence but that with rupture of such an appendix into a peritoneal cavity so far unaffected or the seat of a serous effusion the results of the entrance of grossly infected appendicular contents are likely to be perilous Herein lies the danger of obstructive appendicitis as has been clearly pointed out by Sir David Wilkie and if as is easily possible the symptoms of the disease when confined to the appendix itself are undervalued in their importance the explosion of the highly infected contents into the peritoneal cavity may change the clinical appearances from those of a trivial disorder into the indications of sheer disaster The general effects on the peritoneum and its contained organs receive reference in the chapter on Peritonitis (p 363).

The structures that by adhesion may prevent the spread of peritonitis are naturally the other abdominal contents of which the omentum, small intestine cæcum and ascending colon, mesentery and pelvic organs are all common examples. When the appendix lies behind the cæcum or ascending colon the extraperitoneal fat forms the posterior wall of an abscess the colon the anterior Where an abscess has been permitted to undergo spontaneous absorption there is usually death of some of the omental epiploic or extraperitoneal fat which then presents the white appearance of necrotic and saponified fat

Chronic Appendicitis

By this term is meant the clinical state resulting from effects either of recurring mild acute or subacute attacks or of dysfunction owing to the disposition, peritoneal relations or conformation of the appendix associated possibly with depression of the motor activities of the colon. Nevertheless a true chronic progressive inflammation of the appendix is occasionally seen in which the appendix is thickened, firm fibrous and of an ivory colour sometimes by its appearance even suggesting the possibility that the infection may be by the tubercle bacillus, a supposition very rarely borne out by bacterial or histological investigation In the milder degrees of chronic appendicitis first referred to there are the effects of kinks in producing appendicular pain and what must be called reflex effects on certain sections of the alimentary canal With grosser change there may be thick fibrous strictures and even complete replacement by fibrous tissue so that the appendix becomes a thin firm white strand There is also the effect of sloughing of the mucosa with resulting obliteration of the lumen in one place so that the distal part of the organ becomes distended with mucus If the appendicular wall is weak, either from previous localised destruction of the muscle or from a congenital defect, and mucus be secreted under pressure the mucosa may herniate to form a diverticulum or a mucous cyst or alternatively may burst with the eruption of mucus into the peritoneal cavity Mucous cysts form round themselves by irritation thick fibrous walls whereas mucus bursting into the peritoneal cavity may cause irritative chronic peritonitis in which globules of mucus are surrounded by fibrous tissue and to which the name of *pseudomyxoma peritonei* has been applied.

ACUTE APPENDICITIS

Clinical Picture

The symptoms and signs of acute appendicitis may be grouped according to their pathological origins and for their interpretation may be conveniently assessed as due to the following primary factors (1) *The direct effects of acute inflammation of the appendix* itself (2) the effects on other parts of the alimentary canal (3) the effects on neighbouring structures directly involved by local spread (4) the effects on the peritoneum and (5) septicæmic effects

A The Direct Effects of acute appendicular inflammation are pain associated abdominal rigidity and deep tenderness fever and coated tongue.

1 *Pain* often and typically begins as a generalised upper abdominal or umbilical (i e central) one It is frequently of no great sev rity at the onset but may increase greatly with the passage of a few hours During the course of a few to twenty-four hours it changes i alto settling down in that lace where the inflamed a ndix li this

often in the right iliac fossa The surgeon does not often see the patient before this transference of pain but where he is so fortunate he will usually find that while there may be slight epigastric tenderness there is usually tenderness over the inflamed appendix before the pain is unequivocally centred there The early tenderness that is directly due to inflammation of the appendix is *deep* is commonly unassociated with any noteworthy degree of cutaneous hyperæsthesia and is situated over the organ Thus if the appendix lies between the umbilicus and the anterior superior spine there also is the tenderness With a high lying appendix the tenderness is above the umbilical level in the right hypochondrium or if lowly placed it may be appreciated just above the inguinal ligament or the right pubic bone according to whether the appendix is lying in the false or true pelvis The pain may be entirely pelvic and tenderness may then be difficult to discover by abdominal palpation though there is usually some rigidity of the lower right rectus muscle Rectal or vaginal examination may be necessary to assess the degree of inflammation and position of the appendix. Wherever it may lie if the inflammation is of any severity and sufficient time has elapsed for its evolution, there is local rigidity of the abdominal wall of an intensity corresponding to that of the pain a *rigidity* which increases in degree and extent with the onset of peritonitis The pain of acute appendicitis is probably associated with distension or turgidity of the organ and consequently with traction on its mesentery and the parietal peritoneum It may be constant and increasing from the early hours or it may be colicky in character with intermissions later becoming constant should the attack fail to subside It is a common event for such pain after increasing for some hours or even days to become rapidly better so that the patient thinks that recovery is at hand when in fact gangrene has supervened with death of the peritoneal coat and rupture of the appendix Rupture entails peritonitis but in many cases as noted in the section on pathology this long precedes rupture especially in the cases of blood borne infection Disappearance of the pain, unaccompanied by improvement in the patient s general condition or associated with further deterioration is a serious event indicating the onset of gangrene and imminent if not actual, rupture Appendicitis pain varies in intensity and type not only with the severity of the infection but also with its anatomical hæmatogenous or obstructive origin In the early stages of the last variety pain may be slight and colicky and may thus fail to excite the attention which its origin demands In view of the fact that the obstructed appendix is more prone to rupture than the clear one Herein lies its danger for the early symptoms of appendicular obstruction with inflammation may be slight and no more severe than the patient has accustomed himself (and unluckily perhaps, his doctor) to neglect for a few days on previous occasions when in fact the attacks have been appendicular in origin Yet rupture at once changes the situation so that the patient rapidly becomes gravely ill from peritonitis as the result of which the pain returns but now assumes the characters and distribution typical of peritoneal involvement In this short account of the pain of appendicitis the

2 *The Small Intestine*.—Escape of toxic contents from a pelvic appendix may result in dysfunction of the small bowel Colicky pains are common in neglected patients and partial obstruction may be due to kinking of the ileum should its coils become involved in the formation of an abscess wall Between the onset of the colicky pain and the development of obstruction abdominal distension appears and with it vomiting of an irritative character If the obstruction is not relieved the vomiting takes on a regurgitant nature

3 *The Large Intestine*.—When the colon is affected the usual effect is diarrhœa with the passage of mucus and if the rectum is involved there is tenesmus with the passage of large quantities of mucus and often of blood An associated difficulty in getting rid of fæces is due to the simultaneous involvement of the small intestine and this combination of mucous tenesmus with intestinal obstruction has been named by Sampson Handley "ileus duplex"

4 *The Female Pelvic Organs* may possibly show signs of involvement by the presence of leucorrhœa or menorrhagia.

5 The right iliacus, psoas and obturator internus muscles may go into spasm As a result the right hip may be flexed or there is pain on or resistance to hyperextension and rotation of the joint

D **Effects on the Peritoneum.**—The majority of cases of acute appendicitis show evidence of the existence of peritonitis of some grade, which may be local diffuse or spreading The signs of its presence are pain rigidity and tenderness. Where peritonitis is strictly localised to the serous coat the pain tenderness and rigidity are hardly greater in extent than when there is no peritonitis at all but when this is spreading these three signs affect a larger area of the abdomen, corresponding to the extent of the spread They are not necessarily seen together in equal intensity and each merits a short individual reference

Pain is severest in the early stages of peritonitis while it is spreading to neighbouring parts of the cavity It remains intense until the infection has become widespread or until localisation into a well walled abscess has occurred In the former event with the advent of severe toxæmia and other effects of general peritonitis all pain may disappear but when it does so the patient is moribund.

Tenderness in peritonitis is essentially deep and not a superficial hyperæsthesia except where the peritoneum of the anterior wall is directly involved when there appears an intense hyperæsthesia corresponding in extent to the area of involved parietal peritoneum This is often seen where an inflamed appendix is in contact with the anterior peritoneum and the commonest example is when it lies low down in the iliac fossa and far out where the shallowness of the abdominal cavity results in contact with both anterior and posterior walls Hyperæsthesia may be present in a mild degree with a deeply lying appendix but it is then overshadowed by the deep tenderness and is not therefore of diagnostic importance

Rigidity is the consequence of peritonitis and, when this is strictly limited to the appendix rigidity is likewise localised With diffusion

the rigidity rapidly increases both in intensity and extent It is often, though by no means always, accompanied by immobility of the belly wall and also by localised distension of the abdomen due to local arrest of intestinal movement

The foregoing signs of appendicitis with peritonitis are of the first importance as they give the examiner information as to the exact site of the appendix in all but late cases as well as the extent of the peritonitis As regards their value in estimating the position of the appendix important exceptions are those fulminating cases in which the disease appears to begin with perforation and go on at once to diffuse generalised peritonitis a variety that may be impossible to distinguish from perforation of a peptic ulcer.

Other Clinical Effects —The temperature rises to 102° F and does not fall until the patient recovers or his condition deteriorates seriously The pulse rate quickens with the onset of peritonitis and loses volume. In estimating the degree of the affection, the pulse is probably the most important guide a poorly sustained small pulse with a frequency of over 120 being of serious import The tongue becomes dry and thickly coated and in general peritonitis its centre is brown and the edges red and glazed. The face betrays pain and moderate toxæmia at first, but later the typical Hippocratic facies is seen.

Vomiting at some time is the rule Thus where the attack is *initiated by temporary vomiting with the onset of peritonitis this* symptom returns At first irritative in character it later becomes regurgitant and is then an indication of a grave prognosis Local abdominal distension has been noted General and marked distension indicates the existence of partial or complete intestinal paralysis and is of the gravest significance Diarrhœa occurring in appendicitis with peritonitis is a sign of some gravity and an indication that operative relief is urgently needed.

Local peritonitis and abscess formation Peritonitis may be confined to the region of the appendix from the beginning and may proceed to the formation of an intraperitoneal abscess which appears as a tender swelling From the preceding account of the pathology it follows that a more diffuse area of peritonitis with an area of tenderness several inches square may resolve into a much smaller localised abscess though it must never be assumed that such a subsidence may be surely anticipated There are certain clinical phenomena that accompany this localisation of a more diffuse peritonitis which are noteworthy The pain is apt to diminish, the tongue becomes clean and moist and the temperature rises At the same time the more diffuse tenderness and rigidity of the abdomen, which make it difficult to be certain of the presence of a swelling give place to an easily felt localised mass

E Septicæmic Phenomena.—Septicæmia may occur as a feature of most infections but in abdominal inflammation and especially in appendicitis it tends to assume one well known form, viz., infective phlebitis of the radicles or the trunk of the superior mesenteric vein, leading perhaps to pylephlebitis and multiple abscess of the liver Some examples of appendicitis seem to be septicæmic from the

beginning the infection tending to spread along the veins Clinically such cases have high fever and frequent pulse and as soon as the phlebitic process starts a rigor occurs Tenderness spreads upwards from the appendix and even before it reaches the liver this organ may have become enlarged The picture of appendicitis with infective thrombosis is thus a very clear one It should be particularly noted that in appendicitis rigors are so rare that their occurrence is almost certainly diagnostic of infective phlebitis

Clinical Varieties of Acute Appendicitis

There are a number of common clinical types of appendicitis made up of the various features described As regards general severity and progress the following groups may be seen —

1 Appendicitis with little or no peritonitis followed by subsidence

2 Appendicitis with early diffusing peritonitis and later abscess formation.

3 Appendicitis with diffusing peritonitis and partial localisation only Such are likely to progress to general peritonitis

4 Appendicitis with general peritonitis.

5 Cases of catastrophic violence of onset, in which the early stages are so rapid in evolution that they can hardly be said to be recognisable the disease appearing to start with perforation. Such cases may be difficult to distinguish from perforation of a peptic ulcer

6 Pelvic appendicitis presents a slightly different picture Pain may be absent from the right iliac fossa and is to be expected above the pubes or even in the left iliac fossa from the spread of infection from the pelvis upwards into the abdomen along the pelvic mesocolon. The tenderness is low down above the pubes and immediately above one or both inguinal ligaments and is more prominent on rectal or vaginal examination. Upper abdominal pain and vomiting are likely to be persistent owing to the affection of the loops of ileum in the pelvis Later there will be colicky pain due to obstruction. Still later all tenderness except the rectal may disappear the patient then presenting the appearance of intestinal obstruction of unknown origin Careful attention to the history and a thorough pelvic examination should provide the correct diagnosis. In women neglected pelvic appendicitis may cause serious disease of the tubes and ovaries

7 Retrocæcal appendicitis An appendix lying behind the cæcum is commonly kinked and thus likely to become obstructed. Preliminary warnings in the form of pain likened to stitch are usual, and with the onset of inflammation if the appendix is extraperitoneal, not only is tenderness sometimes difficult to discover but actual abscesses may be overlooked owing to their deep situation.

8 Chronic appendix abscess An appendix abscess may become chronic the early phase failing to receive adequate attention In such patients a tumour develops in the right iliac fossa and a neoplasm of the cæcum or ascending colon is suspected, and a radiological examination may be required to settle the diagnosis.

Differential Diagnosis

Other Gastro-intestinal Diseases cause some confusion, as for example enteritis The condition of the tongue has been referred to The localisation and extent of the tenderness are suggestive being more diffuse in enteritis Pelvic examination must never be omitted It is especially important to remember that in children the signs may be so slight as to deceive the inexperienced observer Enteric fever may present difficulty in its early stages.

Peritonitis Arising from Disease of other Organs.—Perforation of all hollow viscera present more severe clinical pictures and should not be a source of confusion except in the unusual cases of appendicitis of fulminating onset described above A consideration of the symptoms usually enables a correct diagnosis to be made and it should be remembered that a perforated appendix causes a more rapid intoxication with deterioration of the pulse than does the early stage of the perforated peptic ulcer If the appendix is high in position beneath the liver it may be confused with the gall bladder as the site of inflammation, and here the past history and the nature of the onset of the present illness together with the more persistent vomiting of cholecystitis will be helpful

Acute salpingitis provides great difficulty especially in cases of pelvic appendicitis The history the presence of a vaginal discharge the higher temperature the later involvement of the tongue painful and frequent micturition and the findings on vaginal examination should serve to distinguish between the two conditions

Peritonitis of Hæmatogenous Origin is seen in streptococcal septicæmia, and gonococcal infections may be either ascending from the female genital organs or be carried by the blood stream Pneumococcal peritonitis is the affection with which we are most often concerned, and it is described in Chap XXVI It can never be differentiated from appendicitis with absolute certainty and the diagnosis of pneumococcal peritonitis has too frequently led to the death of the patient from an unrecognised appendicitis All patients therefore in whom pneumococcal peritonitis is suspected must be regarded as possible subjects of acute appendicitis and treated as such.

Intraperitoneal Hæmorrhage from any cause but especially when due to a ruptured ectopic gestation or a Graafian follicle may give rise to some doubt A careful assessment of the symptoms and the clinical signs should suffice to make the diagnosis clear

Other Swellings in the Right Iliac Fossa.—The distinction between chronic appendix abscess carcinoma ileocæcal tuberculosis and regional ileitis can usually be made by a barium meal examination

Diseases of the Right Kidney provide the greatest difficulties in the diagnosis of appendicitis In urinary infection with or without stone the temperature is higher and there will be one or more rigors. The full diagnostic problem is discussed in the section on pyelitis (p 761) suffice it to say here that in every case in which the pain starts in the side a renal lesion should be suspected in preference to an appendicular one

Pneumonia.—The variety of pneumonia which is confused with acute appendicitis is that which produces severe right-sided abdominal pain and rigidity without appreciable signs in the chest. The diagnosis may be extremely difficult; the quickened respiration rate, the laboured working of the alæ nasi and high placed areas of hyperæsthesia not seen in appendicitis should draw attention to the chest.

Prognosis of Acute Appendicitis

It is probably true that the large majority of patients suffering from acute appendicitis recover, but that the disease is highly dangerous to life needs no emphasis. In the absence of serious peritonitis the late effects are adhesions and scarring affecting the whole or part of the organ, both of which may lead to kinking, the possible consequences of which have been described. It is rare that the appendix is destroyed by the inflammation, and it may be said, therefore, that a single attack predisposes to others and that with every succeeding attack this predisposition is accentuated.

Where there is peritonitis recovery occurs either by subsidence or with the formation of an abscess which is later drained or absorbed. Recovery from diffusing peritonitis is certainly not the rule without operative intervention, and it is in these early cases of spreading peritonitis that early diagnosis and immediate operation have changed the outlook from one of gloom to the prospect of almost certain recovery. Again, the absorption of abscesses cannot be anticipated with certainty because there are many possible untoward happenings in the process. Of these the most important is the production of a small intestine obstruction due to pelvic abscess, the prognosis of which is always grave.

Treatment of Acute Appendicitis

As a general statement the treatment of disease of this apparently useless but undoubtedly dangerous organ is its removal by operation. Hence it may appear surprising that the management of the various grades and stages of this extremely common disorder is not yet standardised, and that in certain events the relative merits of expectant and operative treatment are still hotly discussed.

For all Early Cases it is universally agreed that immediate appendicectomy is the correct treatment, unless operation implies a high risk on account of other considerations such as disease of the lungs or heart, diabetes, old age or obesity.

Appendicitis with Spreading Peritonitis without Localisation.—Again, in these patients it is the universal practice to remove the appendix without delay except in the presence of such complications as invalidate any operative intervention. It is necessary to stress the overwhelming importance of applying these principles to children without delay.

Cases with Peritonitis showing Signs of Localisation.—It is around these patients that discussion still rages. It is certain that a large number will proceed to complete localisation with or without abscess formation; further, amongst those in whom an abscess forms a proportion continue to spontaneous recovery by the absorption of the

Treatment of chronic appendicitis is the removal of the organ, and if the diagnosis has been correctly made the result is most gratifying

MUCOCELE AND PSEUDOMYXOMA PERITONEI

Mucocele and pseudomyxoma peritonei are rare forms of chronic appendicitis the pathology of which has been described in the section with which this chapter opened. The clinical history is that of recurring attacks of right-sided abdominal pain, after many of which a progressively increasing abdominal distension makes its appearance This is due in the case of the mucocele to the presence of a mucous-containing cyst with a thick wall and of great capacity The cyst is filled with mucus by the ruptured appendix or appendicular diverticulum communication with the cæcum having been closed by previous inflammatory attacks affecting the base of the organ. In the case of the pseudomyxoma the mucus escapes into the general peritoneal cavity where the widespread mucous masses lead to diffuse inflammatory reactions causing chronic peritonitis In either case removal of the offending appendix cures the disease and it should be noted that it is possible for even an experienced surgeon to open the abdomen and mistake the appearances for a tuberculous peritonitis or a diffuse colloid carcinomatous involvement of the peritoneum

ACTINOMYCOSIS OF THE APPENDIX

The appendix is affected more commonly by this streptothrix than any other part of the human body with the exception of the buccal cavity It seems to be a complication of acute appendicitis and has the characters of the disease as seen elsewhere a spreading patchily suppurating indurative inflammation that involves every tissue that it meets, respecting none It spreads into the tissues of the right iliac fossa and leads to multiple intestinal fistulæ

Clinically it is seen in the form of sinuses appearing or often persisting unexpectedly after appendicectomy The sinuses lead into an indurated mass affecting all the structures in the vicinity It is best treated by opening abscesses when they appear by the exhibition of large doses of potassium iodide (up to gr clv daily) and by nursing the patient in the open air by night as well as by day About 50 per cent of patients recover

TUMOURS OF THE APPENDIX

The least uncommon tumour of the appendix is the rare carcinoid or argentaffin tumour It is most commonly found in the appendix as a small yellow growth in the mucosa It behaves as a slowly growing carcinoma and tends to produce eventually secondary growths in the regional lymph glands Such tumours are also seen in the small intestine In this situation they form a well recognised variety of neoplasm causing intestinal obstruction and it is thus among tumours of the small intestine that they may be profitably considered

JULIAN TAYLOR.

CHAPTER XXXIII

THE LIVER AND BILIARY SYSTEM

ANATOMY —The Liver occupies the dome of the diaphragm and is to a large extent under cover of the lower ribs and costal cartilages on the right side the ensiform cartilage and the 6th 7th and 8th costal cartilages on the left side It is reddish brown in colour firm but friable and has a smooth surface It weighs between 40 and 60 oz and in adults is equal to one-fortieth of the total body weight It has superior anterior right lateral, posterior and inferior surfaces.

The anterior superior and right lateral surfaces are in contact with the diaphragm. The superior and anterior surfaces are divided into right and left lobes by the falciform ligament

The inferior surface looks downwards, backwards and to the left is divided into right, left and quadrate lobes, and has the portal fissure near its junction with the posterior surface The left lobe lies to the left of the round ligament and is in relation to the stomach the quadrate lobe lies between the round ligament and the gall bladder and is in relation to the first part of the duodenum and pylorus The gall bladder occupies the cystic fossa of the right lobe which is also related to the hepatic flexure of the colon, the right kidney and the second part of the duodenum The portal fissure contains the hepatic artery the hepatic ducts, the portal vein lymphatics and nerves of the hepatic sympathetic plexus

The posterior surface presents a concavity which lodges the convexity of the 10th and 11th dorsal vertebral bodies The left lobe shows an impression for the oesophagus, between which and the groove for the inferior vena cava is the Spigelian lobe This is covered by the peritoneum of the lesser sac, and is in relation to the aorta. To the right of the inferior vena cava is a depression for the right suprarenal capsule.

The hepatic artery is a branch of the coeliac axis and divides into a right and left branch in the portal fissure to supply the two lobes. The portal vein, formed by the union of the splenic and mesenteric veins, also enters the portal fissure and divides into two main branches. The hepatic veins enter the inferior vena cava. The lymphatics enter the glands in the portal fissure and their radicles run to the glands around the coeliac axis artery or to the receptaculum chyli direct

The right and left hepatic ducts drain the two lobes of the liver and in the portal fissure unite to form the common hepatic duct One inch below the liver this joins the cystic duct to form the common bile duct.

The Gall-bladder is a pear-shaped sac lying in the cystic fossa on the inferior surface of the liver and projecting slightly beyond the anterior border at the level of the 9th right costal cartilage It is attached to the liver by loose areolar tissue the rest of its surface being covered by peritoneum Its neck narrows to enter the cystic duct, which unites with the hepatic duct to form the common bile duct At its junction with the duct the neck forms a pouch named Hartmann's pouch in which stones may become impacted The relations of the gall bladder are above and in front the liver to the left the pylorus below the beginning of the transverse colon and the first

part of the duodenum and to the right the hepatic flexure. It is supplied by the cystic artery which is a branch of the hepatic

The Common Bile Duct is formed by the union of the hepatic and cystic ducts. It runs in the right free margin of the gastrohepatic omentum in front of the foramen of Winslow with the hepatic artery on its left and the portal vein behind and to the left. It passes behind the first part of the duodenum and then runs along the inner margin of the second part in a groove in the pancreatic lobules, to unite with the pancreatic duct when it forms a small dilatation called the Ampulla of Vater The ampulla has an opening into the duodenum which is surrounded by the sphincter of Oddi The length of the component parts of the biliary duct system are as follows common hepatic, 1 to 1½ in. cystic 1½ in common bile duct 3½ in

THE LIVER

ANOMALIES OF FORM AND POSITION

The liver may have a tongue-shaped extension of the right lobe downwards towards the right iliac fossa known as Reidel's lobe It is occasionally seen in connection with an enlarged gall-bladder containing stones but it may be present in the absence of any pathological condition

Displacement of the liver—hepatoptosis—is sometimes seen as a part of generalised visceroptosis

INJURIES OF THE LIVER

Penetrating Wounds are caused by bullets shell splinters, bayonets and knives The immediate danger is hæmorrhage and later infection. If the portal vein is injured, the hæmorrhage is usually fatal. In accordance with the fundamental principles of wound treatment, EVERY wound of this type MUST be enlarged and explored the tear in the liver sutured and the peritoneal cavity drained.

Subcutaneous Ruptures are due to falls from a height crushing accidents direct blows and sudden acute flexion of the trunk. A liver which is enlarged from disease will rupture more easily than a normal one. The right lobe is injured six times more often than the left, and the majority of tears are on the superior and anterior surfaces The dominant feature is intraperitoneal hæmorrhage and its severity may be grouped thus (a) severe bleeding without localising signs (b) a similar type but with pain tenderness and rigidity of the right upper quadrant of the abdomen (c) mild bleeding without typical evidence of internal hæmorrhage and having localising signs in the upper abdomen followed a few days later by enlargement of the liver and mild jaundice In the first two groups the patient presents the classical picture of intraperitoneal bleeding (see pp 144 and 548)

Treatment consists in an immediate laparotomy through a midline incision above the umbilicus The tear in the liver is sutured with mattress sutures of thick catgut introduced on a special liver needle

Gauze packing may also be needed to secure hæmostasis In cases of severe bleeding this may be controlled as soon as the abdomen is opened by compressing the hepatic artery and portal vein between the thumb and a finger in the foramen of Winslow

INFECTIONS OF THE LIVER

Infecting organisms may reach the liver by (1) the portal vein (2) the hepatic artery (3) the bile ducts, (4) the lymphatics and (5) direct spread. The following conditions are found —

Acute:
- (*a*) Acute suppurative pylephlebitis
- (*b*) Acute suppurative cholangitis
- (*c*) Subacute cholangitis.
- (*d*) Catarrhal cholangitis.

Specific:
- (*a*) Gas gangrene
- (*b*) Tubercle
- (*c*) Syphilis
- (*d*) Actinomycosis
- (*e*) Amœbic dysentery

ACUTE SUPPURATIVE PYLEPHLEBITIS

This condition, known as portal pyæmia has become very rare It may occur in infective conditions in any part of the gastro intestinal tract drained by the radicles of the portal vein. Acute appendicitis in the past accounted for most of the cases but sepsis in the rectum still leads to an occasional example of portal pyæmia and rarely a septic umbilical cicatrix in infants is the cause In systemic pyæmia the infection is carried by the hepatic artery and produces a similar pathological and clinical picture The liver is enlarged and studded with multiple small abscesses each arising around the end of a portal capillary Later adjacent abscesses may fuse to form one of some size In portal pyæmia the organisms are *Bacillus coli* and streptococci and in general pyæmia usually staphylococci and streptococci

Clinically it is noticed that after an operation for appendicitis hæmorrhoids or other gastro-intestinal sepsis the patient s progress is *slow and not altogether satisfactory* After a few days the general condition begins to deteriorate and the temperature, which has never settled, begins to rise steadily There is rapid loss of weight pain in the liver area and sooner or later rigors The severity and duration of the condition varies greatly Fulminating cases will be dead in seventy-two hours while others may linger on for weeks.

Treatment is of little or no avail In suitable cases large doses of penicillin may save these patients in the future The real treatment is prophylactic i.e. earlier diagnosis of the causal acute abdominal condition and a more wise preparation for and choice of rectal operations Julian Taylor has recently advised ligature of the superior mesenteric vein a courageous effort to overcome an otherwise fatal catastrophe

Acute Suppurative Cholangitis

This disease is caused by infection reaching the liver either by the lymphatics from an infected gall bladder or by the biliary ducts as in an obstruction to the common bile duct by stones The liver is enlarged and riddled with multiple small abscesses arising round the radicles of the biliary capillaries The ducts themselves are dilated, thickened and filled with thick purulent bile The clinical picture consists in high fever rigors enlargement of the liver and jaundice a fatal issue being a matter of days.

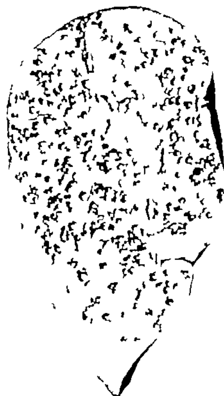


Fig. 342
Gas gangrene of the liver

Treatment is of no avail when the condition is established, but should be prevented by more certain diagnosis earlier surgical intervention and possibly by penicillin.

Subacute Cholangitis

This is localised to the bile ducts and their capillaries a less acute variety of the former condition in that the infection does not spread into the liver and no abscesses are found. Gall-stones may remain in the common bile duct for long periods giving rise to periodic attacks of colic and in the intervals causing either no obstruction or only a partial one The bile is infected, but as long as it can enter the duodenum no signs of infection are evident, although a mild degree of jaundice may persist When however the stone impacts complete biliary obstruction results with a rapid increase in the virulence of the infection Owing to the huge surface area of the biliary ducts, there is a great absorption of toxic bile in a short period. The attack of colic is accompanied, therefore by an abrupt rise of temperature to 104 or 105° F., and later an increase takes place in the depth of the jaundice. As soon as the stone disimpacts biliary drainage is re-established and the temperature falls almost as abruptly as it rose So steep is this rise and fall that the name steeple chart is well merited The stones must be removed and the bile ducts drained, lest an acute suppurative cholangitis supervene

Catarrhal Cholangitis

Catarrhal jaundice is a medical condition which has a surgical interest only in so far as it presents a problem in diagnosis.

Gas Gangrene

Gas gangrene of the liver is seen occasionally in cases where this organism causes infections in the portal area The liver is riddled with small abscesses containing gas and the condition is rapidly fatal (Fig 343)

Tuberculosis

This is rare and may take the form of miliary tubercle a caseous abscess or perihepatitis in tuberculous peritonitis The liver may be enlarged and if there is a mass in the portal fissure there will be jaundice If an exploratory laparotomy is decided upon in an obscure case, it may be possible to evacuate an abscess cavity

Syphilis

Gummata may be seen in both congenital and acquired syphilis They are either single or more commonly multiple and attack the rounded superior and anterior surfaces and the region of the portal fissure. They have an area of perihepatitis over them or a zone of fibrosis around them The liver is slightly enlarged and nodular thickening may be felt. There is pain and the liver is tender ascites is present only if the portal vein is obstructed, and jaundice is rare.



Fig. 344
Actinomycosis of the liver, showing the typical honeycomb appearance.

The *treatment* is that of tertiary syphilis

Perihepatitis hepatitis and syphilitic cirrhosis are described in textbooks of medicine

Actinomycosis of the Liver

The liver is the fourth commonest organ in the human body to be attacked The infection reaches it either by venous or more rarely lymphatic spread from the ileocæcal region or occasionally by direct spread from the lungs through the diaphragm. Abscesses may be single or multiple and present the typical honeycomb appearance (Fig 344). The disease is described in Chap IV

Amœbic Abscess

Liver abscess is a well recognised complication of amœbic dysentery and is seen in the tropics, the Near East and South East

Europe It has been called a tropical or a solitary abscess but as it is not confined to the tropics and as it is multiple in 40 per cent of cases it seems wise and more pathologically correct to use the term "amoebic abscess

The infection reaches the liver by the portal vein, the amoebæ migrating from the colon It is rarely seen in patients in whom the diagnosis of dysentery was made at once and who were efficiently treated with emetine It may occur in cases of mild diarrhœa in which the diagnosis of dysentery has never been discussed The liver can be affected at any time after the original bowel infection, and as long an interval as two years may elapse



FIG. 345
Amoebic abscess of the liver

The abscess is single in 60 per cent of cases and usually affects the upper and posterior area of the right lobe Suppuration is preceded by a gradual inflammatory softening of the liver tissue and if this is near the surface an area of perihepatitis results The wall of the abscess is devoid of any fibrosis and consists of disintegrating liver cells with a leucocytic reaction (Fig 345) The pus is sterile but amoebæ can be recovered from scrapings of the abscess wall It increases slowly until a large size is reached and, as this enlargement is usually upwards the diaphragm is displaced upwards and finally becomes adherent In this way the abscess may erode the diaphragm, enter the lung and be evacuated via a bronchus The pus is either pale grey-green from admixture with bile or anchovy sauce colour from the presence of blood.

Symptoms and Signs—The onset is insidious and obscure and a large abscess may develop before it is diagnosed So successful is medicinal treatment in the early stages that it is imperative that the early clinical picture be clearly understood There is first a complaint of too easily induced fatigue loss of weight and slight but persistent aching deep beneath the lower ribs on the right side, usually in the posterior scapular line This pain may be referred to the right acromio-clavicular joint There is an earthy sallowness of the skin The subjective signs are few in this stage A history of exposure to infection and of mild attacks of diarrhœa should always instigate a search for amoebæ or cysts in the fæces Later the pain becomes more severe from perihepatitis and the liver is tender on deep palpation or heavy percussion and on lateral flexion and extension of the trunk. The temperature is raised to 100 and 101 F and night sweats occur An examination of the blood reveals a polymorphonuclear leucocytosis

with an eosinophilia There may be a tendency to diarrhœa, and the signs of compression of the base of the right lung with a pleural effusion should lead to a searching examination in every patient who has had or might conceivably have had, dysentery X ray photographs show fixation of the right cupola of the diaphragm at a raised level.

Treatment —The stage before suppuration and the small abscess are cured by emetine whereas in the large single abscess the mortality is 20 per cent and in the multiple ones the outlook is hopeless In every case a full emetine course is given viz one grain of emetine sulphate intramuscularly for twelve successive days In the early stages this kills off the amœbæ and the lesion cicatrises up or if an operation is needed later the patient s general condition will have been greatly improved If operation is decided on, the abscess is approached from the side by resecting part of the 9th rib in the mid-axillary line and by going across the pleural cavity which will be obliterated by adhesions The abscess is opened the pus evacuated and the cavity irrigated with a solution containing ten grams of quinine hydrochloride The liver is then sutured and a small drain left down to the suture line for two days The abscess cavity must never be drained unless secondarily infected. In some cases aspiration through a cannula and irrigation with quinine have proved successful During convalescence three grains daily of emetine bismuth iodide should be given from the tenth to the twenty-second day in gelatin capsules



Fig 346
An adenoma of the liver or hepatoma.

GROWTHS OF THE LIVER

These may be classified as follows —

	Benign	Malignant
A Primary	Adenoma Angioma.	Carcinoma Sarcoma
B Secondary		Carcinoma Sarcoma Teratoma.

Primary Growths are very rare The adenoma or hepatoma (Fig 346) is an encapsuled tumour growing either from the liver cells or from the bile capillaries They will rarely be operable although Grey Turner did a brilliantly successful removal in a boy Angioma is common and may grow to considerable size but it gives no

symptoms and requires no treatment The primary liver cell carcinoma is rare and of several types one arising in the regeneration nodules seen in cirrhosis Sarcomata occur as large pinkish white soft tumours They produce enlargement of the liver and soon prove fatal.


Fig. 347
Secondary carcinoma of the liver

Secondary Growths are common in every form of malignant neoplasm, particularly carcinoma of the stomach, gall bladder intestines rectum uterus and breast and also sarcoma of all types particularly melanotic Secondary nodules of carcinoma occurring on the surface are sometimes umbilicated and may be palpable All give rise to a rapid enlargement of the liver with jaundice and ascites (Figs 347 and 348)

CYSTS OF THE LIVER

Hydatid disease is discussed in Chap VI and here only the local clinical features will be dealt with. The liver is more frequently attacked than all other regions taken together between 57 and 63 per cent of cysts being hepatic (Fig 349) There may be one or more cysts which can occupy any part of the liver the upper part of the right lobe being the commonest site. The clinical picture varies according to their size and the complications to which they may be subject. A single hydatid will grow to large size without symptoms causing merely dragging pain from its weight or evidence of pressure on surrounding structures If it becomes infected, the clinical picture is that of a liver abscess and if it bursts into the peritoneal cavity an acute abdominal disaster with great pain and vomiting has occurred. A slight leakage is suggested by attacks of urticaria. It may rupture into a neighbouring coil of intestine and a spontaneous cure result


Fig. 348
Secondary melanotic sarcoma of the liver

Treatment consists in the removal of the cyst when possible and failing this it is exposed the fluid withdrawn and replaced by 1 per cent formalin The wound is then carefully packed off and the germinal lining removed whole or piecemeal

Very rarely a **single cyst** of developmental origin may be found growing from the lower surface near the anterior border It may be mistaken for a mucocele of the gall bladder a hydatid or mesenteric cyst **Congenital polycystic disease** is occasionally associated with the similar condition in the kidneys

THE SURGICAL TREATMENT OF CIRRHOTIC ASCITES

The Talma Morrison operation of omentopexy was first successfully performed by Rutherford Morrison in 1895 The obstructed portal circulation can be relieved if an efficient collateral anastomosis is established between the portal and systemic venous circulations Omentopexy consists in suturing part of the great omentum into the abdominal wall This operation never gave sufficiently satisfactory results to become an accepted procedure Recently direct venous anastomoses have been successfully performed. At first the left renal vein (after nephrectomy) and the splenic vein were united with stimulating results. To-day an anastomosis between the portal vein and the inferior vena cava is being practised. However careful the choice of case may be and in spite of encouraging improvement in some patients this brilliant technical procedure is not the real answer to an exceedingly difficult problem

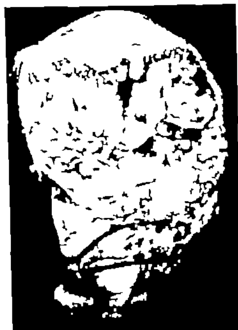


FIG 348.
Hydatid cyst of the liver

THE GALL-BLADDER

Methods of Investigation—A Clinical.—An enlarged gall bladder produces a pear-shaped swelling the long axis of which is directed downwards and inwards from the tip of the 9th right costal cartilage towards the umbilicus or to a point a little below it It moves with the liver on respiration and may be moved from side to side unless adherent from infection. The swelling is dull on percussion and this note is continuous with the liver dullness above while there is resonance on either side of it A diseased gall bladder which is not enlarged will be tender on deep palpation, and this may be made more apparent by Murphy's test This is done with the patient sitting up while the examiner's fingers press deeply around the costal margin. Inspiratory movements are suddenly checked as the tender gall bladder

comes into contact with the fingers, and the patient experiences a sharp jab of pain This test may also be done in the semi prone position when the sign may be elicited in a similar manner

B **Radiography**—X ray photography reveals but a small proportion of gall-stones (Figs. 350 and 351) and a shadow of the gall bladder is difficult to obtain. Barium meal examinations may suggest gall bladder disease from deformities of the pyloroduodenal shadow

C **Cholecystography**—In 1924 Graham introduced a drug which was excreted only in the bile and was opaque to X rays. Further researches led to the adoption of sodium tetraiodophenolphthalein, a drug with slight toxicity but with a satisfactory density in radiography It is given either by the mouth or intravenously The latter is the more reliable route but occasionally produces shock, vomiting shivering and general malaise. The dose is 3 grm. dissolved in 50 c c. of distilled water injected slowly over a



FIG. 350

Three gall-stones in the gall-bladder of boy aged 7 years. They will be seen in a straight line in contact with the shadow of the last rib. Their faint outline is characteristic.



FIG. 351

Multiple gall-stones in an adult. It is rare for the shadows to be so distinct.

period of 15 minutes and photographs are taken at 2 4 8 and 24 hours. The shadow will be at its largest in 4 hours smaller but denser in 8 hours and no longer visible in 24 hours

The technique of oral administration varies in different hands The following has been proved to give satisfactory results At 7 P.M. the patient is given a meal rich in carbohydrates but lacking in fats, and with it swallows the keratin-coated capsule containing 4 to 5 grm of the drug The following morning at 9 A M a photograph is taken, after which a meal rich in fats is given and a second photograph taken at 2 P.M Success depends upon absorption of the drug from the intestinal canal, and this may be hindered either by precipitation of an insoluble compound by the acid of the gastric juice or the too rapid elimination by diarrhœa or vomiting

The drug being secreted by the liver reaches the gall bladder where the bile is concentrated The shadow observed therefore is of the gall bladder only and in health is oval or pyriform in shape and homogeneous in density If occlusion of the ducts prevents bile entering the gall bladder or if this is tightly packed with many calculi, then no shadow will be visible In gall bladders with a few stones the shadow presents a mottled appearance

and lastly tumours or adhesions may cause deformities in the shape of the shadow. If the gall bladder fills but fails to empty in normal time chronic cholecystitis may be inferred. While this method marks a great advance in biliary diagnosis, it must be understood that a negative result *i.e.* absence of shadow does not necessarily prove disease. Positive results are alone reliable (Figs. 352 and 353).

D **The Lyon Duodenal Catheterisation Test.**—A copious flow of bile can be produced by introducing a 25 per cent solution of magnesium sulphate into the duodenum through an Einhorn's tube. The bile can then be withdrawn for examination. In health it should be sterile, contain no cholesterin



FIG. 352.

The appearance of a normal gall-bladder as seen in a cholecystogram.



FIG. 353.

The mottled appearance produced by gall-stones in a cholecystogram.

crystals and a very small amount of mucin. In disease there may be infection with coliform organisms or streptococci, an excess of mucin and cholesterin crystals.

In conclusion, let it be fully understood that by careful clinical observation a correct diagnosis of gall bladder disease may be made in 65 to 70 per cent of all cases, and that simple radiography will raise the percentage to 75. It is only in the remaining 25 per cent that the auxiliary tests should be done. It is not only unnecessary but quite unjustifiable to submit every patient with gall bladder disease to the full routine of cholecystography and duodenal catheterisation.

ANOMALIES OF THE GALL-BLADDER AND THE CYSTIC DUCT

The gall bladder itself is rarely the subject of anatomical variation, but the cystic duct and artery provide a number of anomalies which

may be a real danger in operating unless constantly kept in mind. The duct may vary in length and in the level at which it enters the common duct and may even pass behind it and enter its left side. The cystic artery can arise from the hepatic artery either of its branches or the gastroduodenal trunk, and it may have almost any relation to the cystic duct and gall bladder So many are these variations that no cholecystectomy clamps should be applied until the exact limits of the cystic duct and the common bile duct have been defined and the latter protected.

INJURIES TO THE BILIARY SYSTEM

These are rare except in company with other intra-abdominal injuries or in penetrating wounds In such cases the major injuries overshadow those of the bile ducts but in those rare cases of uncomplicated injury some days or weeks may elapse before a cyst containing bile makes its appearance in the subcostal region. In all cases suture of the tear is required and if the common bile duct is divided it should be ligated and a cholecystgastrostomy performed.

The common duct is sometimes injured during operations in this region, and either a persistent biliary fistula or jaundice of gradually increasing intensity occurs If the gall bladder is present a cholecystgastrostomy is performed but if it is absent the problem is one of great difficulty The proximal end is identified and anastomosed to the duodenum, using a flap from the latter and a small rubber tube at times it is possible to effect a side to-side anastomosis between the greatly distended duct and the pyloric end of the stomach.

ACUTE CHOLECYSTITIS

Etiology —The lines of communication along which infection may reach the gall bladder are the general systemic circulation the portal circulation, lymph stream and biliary ducts. Rosenow has proved experimentally that streptococci isolated from cases of acute cholecystitis in man produce a similar condition in animals if injected intravenously and the evidence of many workers upholds the blood stream theory of infection In typhoid fever organisms are absorbed by the portal radicles taken to the liver in large numbers and excreted *in the bile but acute cholecystitis in the acute* stage of typhoid is very rare and the condition cannot be obtained by injecting organisms into the lumen of the gall bladder For these reasons it seems unlikely that either the portal circulation or the bile ducts are frequent routes of infection. Lymphatic spread accounts for a certain number of cases

The causative organisms are usually streptococci, which can be isolated from the wall of the gall bladder and from the lymphatic glands which drain it Organisms of the coli group including the typhoid bacillus are frequently found in the bile but are probably a secondary infection and not causative

Cholecystitis occurs at any age, but is rare in childhood and becomes increasingly more frequent as the years advance The majority

of cases occur between 40 and 60 years of age the frequency is greater in women, particularly multiparæ than men (7 1) and the fat over

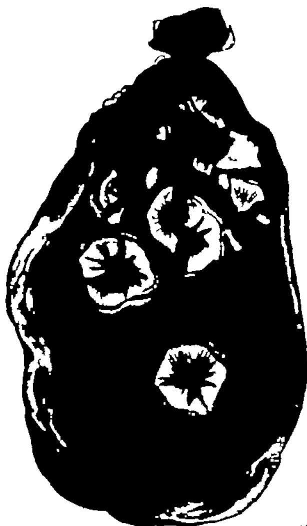


FIG 234

Acute cholecystitis. An enlarged thick walled gall-bladder containing mixed stones. The intensely inflamed mucous membrane exhibits many patches of gangrene

indulgent and lazy are the more prone The etiological relationship between this condition and gall-stones is fully discussed later (p 733)

Pathology.—Infection starts primarily in the muscle coat and spreads to the mucous membrane According to the severity and extent of the infection, certain varieties are described viz. catarrhal, suppurative and gangrenous.

Acute Catarrhal Cholecystitis may occur as an independent infection or *may accompany catarrhal jaundice* The mucous membrane is red and œdematous and there is some swelling in the submucosa. It usually subsides without complications but may lead to some permanent narrowing of the cystic duct thereby predisposing to chronic cholecystitis

Acute Suppurative Cholecystitis is almost always a complication of gall-stones the result of a calculus blocking the cystic duct or *becoming impacted in Hartmann's pouch Often the stone is single* and large and the gall bladder is the seat of chronic cholecystitis As a result of the obstruction the organisms take on a greatly increased virulence and the gall bladder becomes acutely inflamed. The whole thickness of its wall is œdematous red and swollen and adhesions form around it Pus collects in the lumen and unless the stone becomes disimpacted or is removed, the condition will pass into the next stage

Acute Gangrenous Cholecystitis is an advanced stage of the fore-*going The increasing tension within the gall bladder and the virulence* of the infection will lead to thrombosis of the vessels, and gangrene sets in either in patches or of the whole gall bladder (Fig 354) The first area to suffer is usually the neck around an impacted stone Eventually the gall bladder may rupture and infected bile either bursts through the surrounding adhesions and leads to general peritonitis or if the adhesions hold firm an abscess cavity will form locally containing pus one or more stones and a slough which represents all that remains of the gall bladder In all these severe infections the cystic duct will be obliterated and if the gall bladder is not removed or destroyed a mucous fistula will result.

Empyema of the gall bladder is a condition in which a stone has become impacted in the cystic duct or Hartmann's pouch and the virulence of the infection, although too low to produce the gravely acute lesions is severe enough to cause a purulent inflammation of the mucous membrane As a result the gall bladder slowly distends some omentum becomes adherent and a large tender swelling results

Mucocele results from a similar condition of stone impaction, but in a sterile gall bladder As no bile can enter and bile pigments are rapidly absorbed by its wall which secretes large quantities of mucus the gall bladder distends and appears as a large pale thin walled swelling

Symptoms and Signs.—An attack of acute cholecystitis may be the first sign of hepatico-biliary disease but more commonly there is a history of indigestion typical of chronic cholecystitis Again in many ... the condition results from stone impaction and the story of ... will immediately precede it The specific symptoms of acute ...olecystitis are pain vomiting constipation and fever

1 Pain is the first symptom and is felt in the right upper quadrant of the abdomen. It is persistent and colicky and grows in intensity until the tension is relieved either by subsidence of the inflammation, rupture of the gall bladder or operation. The localisation of the pain is at times atypical owing to visceroptosis when the enlarged and tender gall bladder may reach the right iliac fossa

2 Vomiting Shortly after the onset of the pain there is an initial attack of vomiting and this tends to become more persistent than in most abdominal disorders

3 Constipation is obstinate and is due to paralysis of the hepatic flexure of the colon, which is in contact with the inflamed gall bladder In cases of medium intensity the mistake is frequently made of diagnosing acute intestinal obstruction, with failure to recognise the underlying cholecystitis

4 Fever will vary in degree according to the virulence of the infection During the attack in gangrenous cases the temperature may reach 104 F but in empyema it may be only 101 F

On examination there is only one cardinal sign, *i.e.* local tenderness Rigidity is not present in mild attacks and does not appear in severe attacks until the peritoneum is involved. A mass may become palpable below the costal margin consisting either of the gall bladder itself or of the organ and adherent omentum. The pulse rate is raised and there is a marked leucocytosis The analogy between acute cholecystitis and acute appendicitis is often very close the history and the location of the tenderness being the main differences

Treatment—*A* **Expectant.**—A patient suffering from acute cholecystitis is often a poor subject for both anæsthesia and operation. She will be bronchitic and her heart muscle fatty and flabby In such patients the risk of operation is such that an expectant attitude is adopted and the results are sufficiently encouraging to influence many surgeons to adopt this method as the routine treatment The patient is confined to bed kept on a fluid diet and large hot dressings are applied to the abdomen. Morphia in doses of $\frac{1}{12}$ gr is given every six hours and a careful watch kept on the pulse and temperature Appropriate treatment is directed to the relief of pulmonary and cardiac embarrassment

The success of penicillin therapy has now been established. In spite of the impossibility of bacteriological sensitivity controls acute cholecystitis clears up when large doses of penicillin are administered.

B **Operative**—If the general condition is so good that there are no real contraindications to operation, the method of choice is cholecystectomy The patient is well rid of an organ which can never fully recover and which must always remain a source of danger In the cases of acute gangrenous cholecystitis which have not been operated on in the early stages, an abscess cavity will form. Its walls are the omentum and neighbouring structures and its contents are one or more gall-stones and a quantity of pus Little or no trace of the gall bladder walls may be found Removal of the stones and drainage will suffice Cholecystostomy and drainage should never be performed, as the gall bladder does not recover and further if the cystic duct is occluded a mucous fistula will persist on the abdominal wall.

CHRONIC CHOLECYSTITIS

Pathology—Chronic cholecystitis may follow attacks of acute cholecystitis or may be primarily a chronic process In the milder form the mucous membrane is red slightly thickened and shaggy being speckled with little white spots This has been aptly described as the strawberry gall bladder the white spots being deposits of cholesterin in the mucous membrane (Fig 355) Later the walls become thickened and shrunken the sclerosis affecting all coats Stones which are usually present will be tightly gripped and ulceration may occur around them Such chronic inflamed gall bladders may at any time become acutely infected.



Fig 355
A "strawberry gall-bladder"

Symptoms—This condition is described as affecting women of the fair fat and forty" type It is certainly more common in women in the ratio of 7 1 and is particularly seen in fat middle-aged women who have borne children. The syndrome is known as the flatulent or gall-stone dyspepsia and the symptoms are due to the chronic cholecystitis rather than to stones Patients complain of discomfort in the epigastrium and a most distressing flatulence The discomfort bears no fixed relationship to the taking of food sometimes occurring immediately after a meal at other times just before the next This indefinite time relation is the most important feature in the history serving to distinguish this condition from peptic ulcer of the stomach or duodenum The flatulence causes an uneasy feeling of distension loud and embarrassing internal gurglings and external eructations Many patients will complain that they cannot eat foods rich in cholesterin such as eggs butter and fat There may be deep tenderness in the right side of the epigastrium.

Treatment—Chronic cholecystitis is the precursor of many serious conditions amongst them carcinoma of the gall bladder For this reason the gall bladder should always be removed.

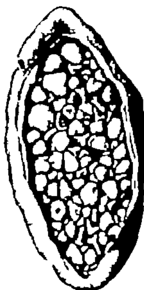


Fig 356
A gall-bladder containing multiple faceted stones.

GALL-STONES

Etiology—The chemical composition of gall stones varies being either pure cholesterin pure bilirubin calcium or most commonly a mixture of the two They may be single or multiple the latter sometimes running into many hundreds of small pigment

stones The larger stones especially in a contracted gall bladder bear well marked facets (Fig 350)

The factors involved in the production of gall-stones are *infection* and disorders of metabolism The *infection* may be in the gall bladder the liver or both As a result three things may happen (1) the bile contains a high percentage of proteins and calcium and numerous centres for simultaneous crystallisation occur (2) the bile acids are so diminished that cholesterin is precipitated and (3) fibrosis of the gall bladder wall leads to an imperfect absorption of cholesterin. *The disorders of metabolism* are chiefly those concerning the fate of cholesterin Hypercholesterinæmia (i.e an excess in the blood) may be produced by disease in response to physiological demand (as in pregnancy) and by the ingestion of too much cholesterin containing food, e.g eggs butter and fats Such excess in the blood may lead to an excess in the bile and pure cholesterin stones may be formed moreover such stones may occur in the absence of infection. The deposition of pure pigment stones is an example of another type of metabolic disorder

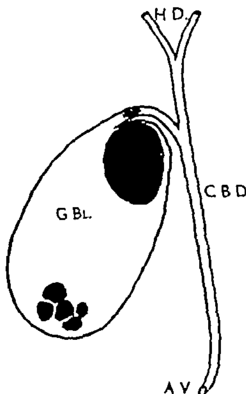


Fig 357

Diagram showing the various positions of stones in the biliary tract.

G.BL., gall bladder; H.D hepatic ducts; C.B.D., common bile duct; A.V., ampulla of Vater; Blue, silent stones; Red, stone in Hartmann's pouch and in cystic duct; Green, stone in common bile duct.

The exact interrelationship and interaction of these processes is not yet fully appreciated but it is evident that stagnation of the bile can no longer be considered an etiological factor nor is the presence of a foreign body nucleus needed. Infection undoubtedly plays an important rôle for stones and cholecystitis coexist in over 75 per cent of cases The close relationship of pregnancy to gall-stones is due not to stasis caused by the enlarged uterus but to the frequency of *Bacillus coli* infections during this period and to the hypercholesterinæmia which accompanies it

Stones may occur at any age the author has recently removed them from a boy of 0 years and a girl of 8 years but the commonest period is between 40 and 50 years and in women of the fat and blonde type who have borne children.

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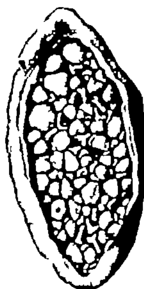


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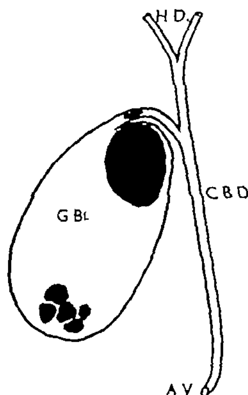


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Stones may occur at any age the author has recently removed them from a boy of 9 years and a girl of 8 years but the commonest period is between 40 and 55 years and in women of the fat and blonde type who have borne children.

Clinical Picture.—The symptoms of gall-stones depend upon their position in the biliary tract and their attempts to migrate. A stone in the gall bladder will present a completely different picture to one in the common bile duct and it cannot be too insistently emphasised that no single composite description of the symptoms is possible. In like manner the treatment is different and for these reasons gall-stones will be described under separate headings as follows:—

A. Those in the gall bladder.
B. Those attempting to leave the gall bladder.
C. Those in the common bile duct (Fig. 357).

Stones in the Gall-bladder.—*Symptoms*.—1. The Silent Stone. Stones may lie quiescent and symptomless in the gall bladder and be discovered during operations for other conditions or during a post mortem examination.

2. Gall-stone Dyspepsia. In these cases the flatulent dyspepsia is due to chronic cholecystitis, the symptoms of which have been described above (p. 730).

Treatment.—If the gall bladder is only slightly affected by chronic cholecystitis and if it appears likely that it will resume normal function, then it should be opened at the fundus, the stones removed and drainage established. In all other cases the gall bladder should be removed. In every case a careful search must be made in the hepatic and common bile ducts to make certain that they contain no stones. Although it is desirable to save the gall bladder whenever possible, it must be admitted that it is rarely justifiable to leave it.

Stones Attempting to Leave the Gall bladder.—The results may be tabulated thus:

A. They may enter the cystic duct	1. Pass through.	
	2. Impact	Acute cholecystitis. Empyema. Mucocele.
	3. Fall back.	
B. They may enter Hartmann's pouch	1. Impact	Acute cholecystitis. Empyema. Mucocele.
	2. Fall back.	

A small stone may succeed in passing through the cystic duct at the first attempt and will then probably pass down the common bile duct and enter the duodenum. A large stone will block the opening of the cystic duct or more likely become impacted in Hartmann's pouch. Clinically, therefore, there are three types:—

1. The stone which passes through the cystic duct. This may have been preceded by a history of flatulent dyspepsia and the patient is suddenly seized with violent pain in the right upper quadrant of the abdomen. Often she describes its maximum intensity as extending from the tip of the 9th costal cartilage upwards and inwards to the midline near the xiphisternum, and it is frequently referred through to the back in the region of the inferior angle of the right scapula. The pain is a true [illegible] and usually of the severest

intensity the victim becoming ashen grey cold clammy and sweating As the attack continues the face becomes lined and drawn and the pulse small weak and rapid In the intervals between the more acute spasms there will be tenderness but no rigidity So great is the pain however that the patient will hardly tolerate examination but will beg for something to relieve the agony At the beginning of the attack there is vomiting and this may be repeated Eventually the stone enters the common bile duct (see below)

2. The impacted stone which later falls back free into the gall bladder In these cases the picture is indistinguishable from the cystic duct colic but its termination is brought about by disimpaction of the stone This usually occurs suddenly often after an attack of vomiting A feeling of soreness remains for several days

3 The permanently impacted stone The attack of colic having reached its maximum intensity decreases in severity and may disappear completely for a few hours to be followed by a second attack of less severity until the pain finally subsides The future of the gall bladder depends upon the presence or absence of infection. If there is no infection the gall bladder becomes distended with mucus—mucocele of the gall bladder—and a few days later the organ can be felt as a pear-shaped swelling in the abdomen If the gall-bladder is infected, the picture of acute cholecystitis becomes engrafted on the colic, or if the virulence of the infection is low an empyema of the gall bladder results (*Fig* 358)



FIG. 358

A gall bladder opened to show a stone impacted in Hartmann's pouch, with very thickened walls and an intensely inflamed mucous membrane. An example of acute upon chronic cholecystitis.

Treatment —Stones which succeed in passing into the common bile duct will usually enter the duodenum A small number will be held up in the duct and need appropriate treatment. Every stone which impacts temporarily or permanently requires operative extraction the gall bladder being removed

Stones in the Common Bile Duct.— *A* Those that pass through at the first attempt. These stones cause severe colic Some patients describe the area of maximum intensity as stretching from the xiphisternum downwards and slightly outwards to a point two-fingers breadth below the transpyloric plane So severe is the pain that patients have died from the shock and exhaustion it produced The attack ends abruptly as the stone enters the duodenum Vomiting may be a prominent feature and afterwards there may be a tinge of jaundice but it is transient

B Those that become impacted These cases are characterised by recurrent attacks of colic at *varying intervals* accompanied by high fever at the onset and jaundice afterwards The temperature which is due to subacute cholangitis (p 718) rises abruptly within the first

2 hours of the attack to 104 or 105 F and falls equally rapidly within 2 days (the "steeple chart") Jaundice will appear within 24 hours and its subsequent progress depends upon the frequency of the attacks and the degree of the obstruction If one stone is present and a long interval occurs between each attack the jaundice will disappear completely to recur after each attack If however the intervals are short and several stones are present causing some permanent partial obstruction the jaundice becomes deeper after each attack, slowly fading for a time but never entirely disappearing This variation in the depth of the jaundice is of the greatest diagnostic importance

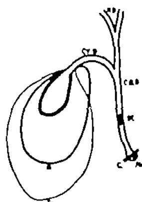


FIG. 359

Diagram illustrating Courvoisier law

Y normal gall-bladder; S, the thickened shrunken gall-bladder of chronic cholecystitis associated with ST a stone in the common bile duct; G a greatly distended gall bladder associated with C, a growth in A.V the ampulla of Vater

An examination will reveal some rigidity during the spasms but none in the intervals, and there will be tenderness over the upper abdomen. In the intervals deep tenderness can be elicited over the duct but not over the gall bladder which is impalpable It is useful to bear in mind Courvoisier s law in these cases viz In jaundice due to stone there is no enlargement of the gall bladder but in cases due to carcinoma of the head of the pancreas a large palpable gall bladder is present (Fig 359)

Treatment —Every stone in the common bile duct must be removed at the earliest opportunity to avoid any further damage to the liver The dilated duct is opened above the duodenum and the stones milked up or down into the opening and removed with forceps or a blunt scoop A blunt probe is then passed into the duodenum to make sure that no stone has been overlooked. Stones impacted in the ampulla of Vater may be too firmly embedded to be moved An attempt is made to grasp them with special forceps introduced through the bile-duct incision from above If this fails the operation known as transduodenal choledochotomy is performed in which the anterior wall of the duodenum is incised opposite the ampulla this being then dilated from within the duodenum and the stone extracted. The duodenal incision is then sutured. In every case the hepatic and common bile ducts are washed out with saline and a tube stitched into the common bile duct to drain the bile for seven to ten days

Complications —These are acute and chronic cholecystitis mucocele and empyema of the gall bladder local and general peritonitis carcinoma of the gall bladder external and internal biliary fistulæ acute subacute and chronic cholangitis acute and chronic pancreatitis All these are described under their respective headings except the fistulæ

An External Biliary Fistula may be either spontaneous or operative The spontaneous variety is now a surgical curiosity being due solely to neglect The inflamed gall bladder becomes adherent to the anterior abdominal wall at some point between the right costal margin

and the umbilicus the inflammatory process spreads into the abdominal wall and finally bursts through the skin pus and gall stones being extruded No bile will flow as the cystic duct is certainly occluded An external fistula will occur after drainage of a gall bladder whose cystic duct is occluded or obstructed and a discharge of mucus persists At times the wound may attempt to heal and pain due to distension of the gall bladder occurs until the fistula reopens The treatment is cholecystectomy except in the case of old and fragile patients who may need a small silver drainage tube fitted to prevent the fistula contracting A fistula draining bile will result after removal or drainage of the gall bladder if an unsuspected obstruction of the common duct is present Treatment is the relief of the obstruction

An **Internal Biliary Fistula** is produced by the adhesion of an inflamed gall bladder to the duodenum or hepatic flexure of the colon. Ulceration of the gall bladder wall occurs around the stone the process spreads into the wall of the intestine and finally a fistula is formed through which the stone passes. In the case of a stone in the small intestine acute intestinal obstruction may follow

GROWTHS OF THE BILIARY SYSTEM

Carcinoma of the Gall bladder.—The great majority (over 80 per cent) of these growths occur in connection with gall-stones they are more common in women than men are seen after the age of 55 years and attack the fundus more frequently than the neck They are columnar-celled in type Fortunately it is a rare growth, for its insidious onset usually results in its being inoperable when first seen clinically Patients in whom there is a long-standing history of chronic cholecystitis become aware of a painless swelling under the right costal margin or in some people secondary involvement of the liver may provide the first indication whilst in others the picture is sufficiently severe to lead to a diagnosis of acute cholecystitis. On examination an irregular nodular swelling will be felt in the position of the gall bladder Later pain, jaundice and ascites supervene

Treatment is essentially prophylactic in that every thickened gall bladder should be removed The growth will rarely be operable but if possible the gall bladder and neighbouring glands should be resected with a wedge of liver

Carcinoma of the Common Bile Duct.—This occurs as a scirrhous ring stricture at any part of the duct including the ampulla, and rarely in the hepatic ducts The onset is insidious jaundice of gradually deepening intensity being the *chief* symptom The gall bladder will be greatly distended and easily *palpable* In rare cases it may be possible to resect the stricture but usually a palliative cholecyst-gastrostomy is all that can be done

OPERATIONS UPON THE BILIARY SYSTEM

Cholecystectomy.—*Position*.—The patient is placed supine upon the table, so that the lower dorsal and upper lumbar region is over the mechanical bridge which is embodied in every modern table By raising it the spine

is pushed forward in an exaggerated curve thus bringing the structures in the free margin of the gastrohepatic omentum nearer to the surface This bridge is used as a routine by many surgeons, but in many cases it is unnecessary and is not without some heritage of pain and stiffness in the back. In difficult cases it should certainly be employed *If the table has no such attachment a sand bag or air bag will suffice.*

A choice of three incisions lies before the surgeon, namely a midline supra-umbilical a paramedian through the right rectus sheath and Kocher's incision (p 578) The peritoneal cavity being opened, the gall bladder is identified by passing the hand beneath the liver and keeping contact with its inferior surface A pair of Allis's forceps is applied to the fundus in order to steady the gall bladder while hot saline packs are introduced to shield and displace the stomach hepatic flexure of the colon and omentum Facility safety and success depend upon a perfect exposure and, unless the structures of the cystic pedicle and common bile duct are fully visualised, the patient is in danger With gentle but adequate retraction this area is fully displayed. Traction upon the gall bladder fundus makes recognition of Hartmann's pouch a simple matter and upon it a second Allis's forceps is placed. Gentle traction upon it displays the peritoneal reflexion from pouch to cystic duct This crescentic fold is incised close to the pouch with curved scissors Blunt dissection brings both cystic duct and artery into view *the peritoneum being cut in short segments as the dissection proceeds. At this stage the cystic duct and common bile duct should be clearly defined.* The crucial part of the operation has been reached and clamps must never be applied until the surgeon is absolutely sure that he has identified without a shadow of doubt both cystic and common bile ducts Two pairs of cholecystectomy forceps are now applied to the cystic duct well clear of the common duct. The former is divided and another pair of forceps placed upon the cystic artery which is cut between them this is the ideal procedure, *but it may be easier and equally safe to include both duct and artery in the same clamp*

By gentle traction upon the distal clamps the peritoneal reflexion from liver to gall bladder is displayed and divided by scalpel whereupon the gall bladder can be freed from its loose attachments to the liver by gentle dissection with a gauze swab The cystic duct and artery are now securely ligated and this area carefully inspected for any minor bleeding points These will be picked up and tied The bare area of the cystic fossa is covered by approximating its peritoneal edges with three to five mattress sutures. A small drainage tube is placed down to the cystic stump and the abdomen closed.

Cholecystostomy—*Approach to and identification of the gall bladder is as described above* The fundus is held by two Allis's forceps and packs placed around it to protect the peritoneum. The gall bladder is emptied by means of a Potain's aspirator and then opened at its fundus Stones are removed by scoop and forceps after which a rubber tube of medium bore is introduced and fixed by a catgut stitch to the cut edge A purse-string suture invaginates the cut margin so that no raw area is visible. The *abdomen is closed*

Choledochotomy or Removal of Stones from the Common Bile Duct.—Preliminary stages are as for cholecystectomy The operation area being displayed, neighbouring viscera packed off and held aside the free edge of the gastrohepatic omentum is identified. It contains the portal vein behind common bile duct in front and to the right and the hepatic artery in front and to the left Its recognition may not be easy but by a careful display and identification of each landmark the surgeon should be confident

of its exact position If any doubt exists it is wise to explore with a needle and syringe to obtain bile before an incision is made this will prevent an opening into the portal vein It must be admitted that as a result of disease previous operation or abnormal anatomy this operation may present great difficulties Only by proceeding carefully step by step will safety be assured

The common bile duct having been identified two guide sutures of fine catgut are introduced into its margins, thus enabling the surgeon to steady and render taut the duct. An incision is now made in its long axis Stones are milked up from below or down from above and removed Careful palpation having failed to demonstrate any other stone the patency of the ampulla is tested by passing a sound down into the duodenum A small rubber tube is inserted into the duct and passed upward for 1½ in. It is fixed by a suture of ten day 0000 catgut.

Trans- or Retro-duodenal Approach.—When a stone is so firmly impacted in the ampulla that it cannot be moved, it must be approached either by incising the anterior duodenal wall or by mobilising the second part of the duodenum and turning it to the left when the duct can be opened from behind. There can be no doubt that the former route is the safer

Cholecystgastrostomy—In cases of obstruction to the common bile duct which cannot be radically treated, relief of jaundice is an important matter because of the intolerable itching by which it is often accompanied. This may be effected by anastomosing the fundus of the gall bladder to the anterior surface of the pyloric antrum This should always be preferred to an anastomosis between the gall-bladder and the jejunum.

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CHAPTER XXXIV

THE PANCREAS AND THE SPLEEN

THE PANCREAS

ANATOMY.—The pancreas is a gland of double function (it produces external and internal secretions) lying behind the peritoneum in front of the aorta, vena cava and renal vessels. It consists of a head, a neck, a body and a tail.

The head lies in the concavity of the duodenum. Above it is the pylorus and behind are the right renal vessels, the inferior vena cava and the common bile duct. In front it is covered by the beginning of the transverse mesocolon.

The neck arises from the anterior surface of the head towards its left edge and passes upwards and to the left to join the body. Behind it in a groove between it and the head runs the superior mesenteric vein to join the splenic vein and so form the portal vein.

The body passes across the middle line at the level of the transpyloric plane to reach the tail at the beginning of the lieno-renal fold. It is triangular on cross-section, having posterior, anterosuperior and antero-inferior surfaces. The posterior surface has behind it the aorta, left renal vessels, hilum of the left kidney and splenic vein; the anterosuperior is covered with the peritoneum of the lesser sac and is in relationship with the posterior wall of the stomach; the antero-inferior is covered with the peritoneum of the greater sac and has coils of small intestine in relation to it. Along the anterior border runs the attachment of the transverse mesocolon. The tail lies in the lieno-renal fold and reaches the hilum of the spleen.

The pancreatic duct starts in the tail and runs through the whole length of the gland to open into the second part of the duodenum, either separately or having previously joined with the common bile duct just proximal to the ampulla of Vater. One or more accessory ducts may be present opening into the duodenum above the ampulla.

The blood supply is from the superior pancreatico-duodenal branch of the gastroduodenal, the inferior pancreatico-duodenal branch of the superior mesenteric and branches of the splenic artery. The veins join the splenic vein.

Methods of Examination.—Clinical examination is difficult owing to the depth of the pancreas within the abdomen, and laboratory tests for detecting its insufficiency are hardly satisfactory. The fæces in pancreatic deficiency are laden with fats and fatty acids (steatorrhœa) and there is an increase in the amount of undigested muscle fibre (azotorrhœa). Diarrhœa is a constant symptom. The best laboratory test is the diastase reaction in the urine, which normally contains 10 to 30 units of diastase and in disease may contain 200 units.

INJURIES are very rare, occurring in conjunction with other severe abdominal accidents, and are usually fatal. Mild injuries may be the cause of pseudopancreatic cysts.

ACUTE PANCREATITIS

The old classification into hæmorrhagic gangrenous and suppurative is unsound as all three processes are present in severe cases The clinical picture and the pathological findings depend on the virulence of the process, and the following classification is more satisfactory —

(1) Fulminating (2) acute (3) subacute and (4) catarrhal

Etiology —This is one of the most serious of all the abdominal emergencies and is not common The author although having the unique experience of operating on two cases in one evening at St Mary s Hospital, has had only eighteen examples in the past thirteen years of these ten were men and eight women and in all of them there were present gall-stones of the small multiple variety Gall bladder disease with or without stones is present in all cases

Pathology —Pancreatitis can be produced experimentally by injecting bile into the pancreatic duct Normal bile produces chronic pancreatitis, while infected bile causes the typical lesions of acute inflammation. It is suggested that if a small stone is impacted in the sphincter of Oddi, bile from the ampulla is forced back along the pancreatic ducts on the other hand, some observers deny that this is possible At operation although hundreds of small stones may be present it is very rare to find one actually blocking the outlet of the ampulla. The question is therefore one of considerable difficulty Probably some cases are due to a reflux of bile along the pancreatic ducts but in others the infection is carried from the primary focus in the gall bladder to the pancreas by lymphatics The infecting organism is usually a streptococcus

The naked-eye changes are produced by the conversion of trypsinogen into trypsin which results in self-digestion of the pancreas and erosion of vessels At first the pancreas becomes swollen red or purple and infiltrated with small hæmorrhages Owing to the escape of ferments, fat is converted into salts of the fatty acids and areas of fat necrosis occur in the omentum mesentery and peritoneum generally These are small, firm white areas in the fat beneath the peritoneum which cannot be mistaken for anything else Later hæmorrhage becomes more widespread in the gland and infection and auto-digestion cause sloughing of the gland substance There may be free blood in the greater sac and there will certainly be a blood-stained exudate in the lesser sac of the peritoneum

In the less acute or subacute varieties the hæmorrhage and the sloughing are less marked and a slower suppurative process is seen. As a result a large mass may be formed of the infected pancreas gall-bladder omentum and surrounding structures with an abscess cavity in the centre

Symptoms and Signs —In the fulminating variety the pain is so severe the collapse so marked and the patient s distress of mind so great that it is probably the most terrible of all abdominal emergencies The onset is sudden, agonising pain being felt in the epigastrium going through to the costolumbar angle on both sides There is an initial attack of vomiting which may later become a prominent feature in some

patients and collapse is profound. There will be absolute constipation The pulse is thin, running and rapid and the temperature subnormal Cyanosis is often well marked, due to rigidity of the diaphragm On examination the upper abdomen is very tender and completely rigid, and there is usually tenderness in the right costolumbar angle

The acute variety presents a very similar picture except that the pain and collapse are not so severe and the prognosis not so grave After *subsidence of the acute onset pain and tenderness persist but rigidity* becomes less marked and abdominal distension takes its place while an indefinite tender swelling becomes palpable deep in the abdomen

The subacute variety is still less severe The onset is gradual and collapse is not present The picture resembles an acute cholecystitis rather than an abrupt abdominal disaster There is a gradual onset of epigastric pain becoming severe in a few hours an initial attack of vomiting no cyanosis and the temperature is raised to 102 or 103 F In the early stages there is tenderness and rigidity in the right upper quadrant of the abdomen and later a large ill-defined swelling appears *In some cases this embodies the whole pancreas* and can be recognised as such by its shape and position. In others the mass is due to adhesions with all the adjacent structures. In untreated cases operation reveals an abscess with a central slough of the head of the pancreas

Catarrhal Pancreatitis is seen as a complication of some of the infectious fevers *e.g* mumps.

Diagnosis —After forty-eight hours a discoloration is said to appear in the loin on one or both sides below the last rib and Loewe s adrenalin conjunctival test is positive in acute pancreatitis Such tests are of academic interest only and if relied upon can lead only to loss of valuable time In the grave varieties, the condition is usually mistaken for a perforated peptic ulcer and in the less severe for acute cholecystitis, which may be coexistent In neither case does the error matter as the patient s condition will obviously demand a laparotomy and the fat necrosis immediately establishes the diagnosis Nevertheless there are features in the disease which should lead to more frequent correct diagnosis and its possibility should always be borne in mind in grave upper abdominal emergencies In the past conflicting reports cast doubt upon the reliability of the diastase test in the urine Recent work has shown that the diastase index is always high provided the urine is tested during the acute phase of an attack It falls to normal very quickly

Treatment consists in adequate drainage of the pancreas and of the common bile duct The pancreas is fully exposed the peritoneum over it incised and tubes placed down to it Care must be taken to drain the body as well as the head and several tubes may be needed. The *common bile duct is opened* above the duodenum (any contained stones being removed) flushed out with saline and a tube stitched in. If the patient s condition permits, the gall bladder is opened and stones removed but this is not essential in the saving of life The gall bladder should be preserved lest a chronic pancreatitis follow recovery and a cholecystgastrostomy be needed.

The results of this grave condition should be improved The important factors are adequate drainage of the pancreas over a long

period (in the author's successful cases the tubes remained in between twenty-eight and thirty-seven days) and drainage of the common bile duct Of the author's eighteen cases, ten are alive and well One fulminating case lived for five weeks and died of broncho pneumonia with resolution of the pancreatic condition as shown at post mortem and one died twenty five days after operation because the left end of the body was inadequately drained the remainder of the pancreas having cleared up Recently it has been claimed that if a correct diagnosis can confidently be made better results follow expectant treatment In view of the acknowledged difficulty of diagnosis these claims are not easy to establish

CHRONIC PANCREATITIS

This is a medical disease which is sometimes brought to the surgeon for treatment Chronic infection leads to fibrosis which may be either interlobular when the gland is shrunken and hard but the islands of Langerhan's escape or interacinar as seen in diabetes mellitus and hæmochromatosis The primary focus is in the gall bladder or duodenum and infection is carried to the pancreas by lymphatics The clinical history is vague and unreliable but the symptoms of the causative factor will be present with steatorrhœa azotorrhœa and wasting Jaundice will occur if fibrosis of the head of the pancreas affects the common bile duct or ampulla

The *treatment* consists in relief of the cause combined with a cholecystgastrostomy

PANCREATIC CYSTS

The pathology of pancreatic cysts is still imperfectly understood. They may be classified as follows —

1 True cysts
- (a) Retention cysts
- (b) Cystadenoma.
- (c) Congenital polycystic disease
- (d) Hydatid cysts
- (e) Blood and lymph cysts

2 Pseudocysts
- (a) Traumatic
- (b) Inflammatory
- (c) Neoplastic

True Cysts are rare Retention cysts occur as the result of *chronic* pancreatitis or of any condition causing blockage of the main ducts. Cystadenomata are exceedingly rare and may be multilocular or contain intracystic papillomata Congenital polycystic *disease* will sometimes be seen in the pancreas as well as in the kidneys.

Pseudocysts are usually collections of fluid in the lesser sac of the peritoneum They are due to injury whereby the peritoneum covering the upper surface of the pancreas is torn and blood and pancreatic fluid enter the lesser sac A mild peritonitis seals off the foramen of Winslow and a closed sac results The injury is of mild severity no grave internal trauma results, and within forty-eight hours the patient has recovered. After a few days or weeks a swelling can be palpated in the epigastrium

The true cysts are lined with epithelium and the pseudocysts with endothelium They both contain an alkaline brownish and turbid fluid, with albumen and usually pancreatic ferments but without bile or urea.

Symptoms—The patient is usually a man past 40 years of age and there may be a history of injury or pancreatic disease The cyst may grow either into the pancreas and seriously disorganise it, or away from it and press on adjacent structures. The clinical picture therefore varies considerably There may be slight epigastric pain, trivial indigestion, a little flatulence and constipation. In other cases with pancreatic deficiency there may be rapid wasting diarrhoea and a sallow complexion. If the bile duct is pressed on, jaundice will develop All cases present a cystic swelling which is more commonly on the left than the right though it may be centrally situated It comes to the surface either (1) between the stomach and the liver (2) between the stomach and transverse colon (3) below the transverse mesocolon amongst the coils of small intestine (4) between the layers of the mesocolon pushing the transverse colon forward or (5) by passing outwards into the loin. Diagnosis is never easy as they are rare swellings and many other retroperitoneal cysts occur but it should never be mistaken for a hydronephrosis which can be recognised at once by a pyelogram.

Treatment presents many difficulties Every case should be operated on but the ideal procedure of excision or enucleation is not always practicable Failing this the cyst must be drained either by tube by gauze packing or by marsupialising it to the abdominal wall. Some surgeons prefer to explore the cyst from the front and obtain drainage through the loin. These cases tend to develop a persistent sinus which may become a distressing affliction owing to digestion of the wound by pancreatic ferments

PANCREATIC CALCULI

These are very rare are composed of calcium carbonate and magnesium phosphate and are formed in the pancreatic ducts if these are partially obstructed They are found very seldom in life and then only as a surprise in an X ray film Their symptoms are varied and not pathognomonic Occasionally after a severe attack of colic they may be recovered from the stools

GROWTHS OF THE PANCREAS

Adenoma cystadenoma and sarcoma are described but carcinoma is the only one of importance Both primary and secondary forms occur but the primary carcinoma of the head of the pancreas is not so common as would appear because some of the cases so described are in reality either growths of the lower part of the common bile duct or chronic pancreatitis It is a spheroidal-celled carcinoma simplex and is densely scirrhus in type It gives no symptoms until it presses on or involves the common bile duct It occurs more often in men than women, usually after the age of 50 years Jaundice is frequently the first symptom and having appeared becomes persistent varying only by a steady deepening in intensity According to

Courvoisier's law the gall bladder becomes palpable and distended and there is usually little difficulty in differentiating these cases from those in which a stone is impacted in the common duct Later pressure on the portal vein causes ascites and on the inferior vena cava swelling of the legs. In most cases the prognosis is hopeless and all that can be done is a palliative cholecystgastrostomy to relieve the jaundice This is always justified as it prevents the intolerable itching from which many of these patients suffer Recently successful attempts have been made to resect the head of the pancreas together with part of the stomach and the first, second and part of the third part of the duodenum

Of recent years a tumour of the cells of the islets of Langerhans has been described under the name of nesidioblastoma It is usually of small size in the nature of an adenoma It is associated with severe paroxysmal attacks of hypoglycæmia, in the presence of which the possibility of this tumour should be considered Complete relief follows its removal

THE SPLEEN

Anatomy.—The spleen lies in the left hypochondrium beneath the 9th 10th and 11th ribs. It is surrounded by peritoneum which is reflected from its surface at two places, one fold attaching it to the stomach the gastro-splenic omentum, and another passing to the left kidney the lieno-renal ligament. The outer surface is in contact with the diaphragm while the visceral surface is related to the stomach the left kidney the splenic flexure of the colon and the tip of the pancreas The splenic artery is a branch of the coeliac axis the splenic vein joins the mesenteric veins to form the portal vein and the lymphatics enter the glands in the hilum, their efferents going to the glands around the coeliac axis artery The anterior border is sharp and contains one or more definite notches, which are preserved in most types of splenic enlargement.

Function.—The spleen is a member of the hæmopoietic system. It is the factory of white blood cells, the destroyer of worn-out blood cells of all types and of all foreign constituents in the blood. Its presence is not essential to life the other members of the system being capable of taking on its functions After splenectomy there is a slight temporary secondary anæmia, the yellow bone marrow is largely replaced by red marrow and there is some hyperplasia of the lymphatic tissue in the body

ANOMALIES

Accessory Spleens are sometimes seen in the gastrosplenic or great omentum in the form of small spherical bodies of splenic tissue Occasionally the spleen itself is replaced by a bunch of small spleens

Movable Spleen is a condition found occasionally in thin parous women in whom the pedicle is greatly lengthened and the spleen able to move freely within the peritoneal cavity It may reach to the right iliac fossa and has been found in the sac of an inguinal hernia. If it occurs apart from generalised visceroptosis, it is due either to injury or to some splenic disease It may be symptomless or a vague dragging pain may be felt A tumour easily recognised as the spleen is felt within the peritoneum. Many cases can be made comfortable with an abdominal belt but failing this the spleen should be removed. No useful purpose is served by attempting to stitch it up (splenopexy)

Torsion may occur in a movable spleen by axial rotation, so that its vessels become thrombosed. The symptoms are comparable to those of a twisted ovarian cyst chiefly pain and vomiting The spleen should be removed

Injuries of the Spleen.—The *symptoms of rupture of the spleen* are those of intraperitoneal bleeding and are described in Chap. XXVI p 549

INFECTION CYSTS AND GROWTHS

Abscess of the spleen may be metastatic infarctive or traumatic. Metastatic includes those occurring in the infective fevers pyæmia and septicæmia infarctive in the breaking-down of infarcts in infective endocarditis and traumatic when a hæmatoma in the spleen becomes infected. Lastly abscess may result from the suppuration of a hydatid cyst It is a rare condition and always a very serious complication of the coexisting disease It causes a painful and tender enlargement of the spleen with high fever and rigors The abscess may burst into the peritoneal cavity any adjacent hollow viscus, the pleural cavity or through the abdominal wall on to the surface.



FIG 360

A spleen showing multiple deposits from a case of malignant lymphoma.

The ideal *treatment* is splenectomy but owing to dense adhesions drainage is usually the only safe procedure

Tuberculosis of the spleen causes a hard and painful enlargement and is rare apart from the miliary form. Syphilitic gumma is also rare

Cysts are usually *hydatid* in origin, but rare examples are on record of blood, serous and lymphatic cysts.

Primary Growths are rare only angioma and sarcoma occurring, the latter forming a hard nodular and rapidly growing tumour **Secondary deposits** are also rare except in connection with malignant lymphomata (Fig 360)

THE SURGICAL SPLENOMEGALIES

1 **Splenic Anæmia or Banti's Disease.**—In this disease the spleen is the primary seat of the disease and only in the later stages is cirrhosis of the liver added to the picture There is an introductory

stage of insidious onset characterised by a mild anæmia lassitude and possibly a hæmatemesis then follows the splenomegaly and later a third stage of hepatic cirrhosis to which only can the term Banti's disease be properly applied. The spleen is hard and enlarged to or beyond the umbilicus It gives rise to dull dragging pain due to its weight. The anæmia is of the secondary type with a low colour index and a leucopænia. It may be many years before the liver is affected. Hæmatemesis may be severe in some cases or absent in others Splenectomy results in cure if performed before hepatic involvement occurs, and even after this some improvement may be expected

2 **Acholuric Jaundice.**—This disease may be either familial or acquired and is characterised by a moderate enlargement of the spleen, recurrent attacks of mild jaundice and a mild secondary anæmia There is no bile in the urine the stools are normal, and the jaundice is more a dull grey earthy discoloration than the yellow colour of obstructive lesions In the majority of cases there is an increased fragility of the red blood cells in hypotonic saline During attacks there is usually mild fever and an increase of the anæmia Splenectomy cures the anæmia and jaundice but the fragility of the red cells remains The prognosis is not so good in the acquired type

3 **Purpura Hæmorrhagica,** especially if an essential thrombocytopænia is present may be accompanied by a moderate degree of splenic enlargement and a very low platelet count in the blood. Splenectomy has become the established method of treatment for the severe cases, and in spite of the danger of hæmorrhage it is a justifiable risk, as the prognosis without operation is hopeless.



FIG 361
A typical "hard bake" spleen in lymphadenoma.

4 **Gaucher's Splenomegaly** is marked by an enormous enlargement of the spleen in childhood. It may be familial and in some respects resembles splenic anæmia, but the anæmia is slight and hæmatemesis does not occur though there may be bleeding from the nose and gums It is in the nature of a lipoidosis in which the long bones may be affected. Splenectomy has no effect and should not be advised. The prognosis is not good.

5 **Malarial** enlargement of the spleen is a danger to the patient in two ways. First owing to its friability it is easily ruptured from mild trauma (in the East a recognised method of removing one's enemy is to strike him in the left side and a special flat wooden weapon exists for this purpose) and secondly some parasitologists believe that it is the spleen which harbours the parasite For these reasons a splenectomy should be performed.

6 **The Spleen** is enlarged in myeloid and lymphatic leukæmia polycythæmia and lymphadenoma (Fig 361) as well as in several of the reticuloses. In none of these should splenectomy be considered.

OPERATIONS UPON THE SPLEEN

Splenectomy.—The spleen can be exposed through three alternative incisions (1) midline supra-umbilical, (2) left paramedian through the left rectus sheath or (3) a left subcostal approach similar to Kocher's gall-bladder incision on the right side Splenectomy may be rendered extremely difficult if not impossible because of adhesions between its convex upper surface and the diaphragm. In many diseases which cause splenomegaly some perisplenitis is present and adhesions must be expected

The abdomen being laid open, the surgeon introduces his right hand beneath the left anterior abdominal wall and passing outwards and back wards beneath the diaphragm easily locates the spleen Its convex surface is examined for adhesions Should none be present the lienorenal fold of peritoneum is divided and the spleen rotated forwards and to the right, thus displaying the pedicle from behind Section of the peritoneum is carried past the vessels entering the hilum. Ideally the splenic artery should be identified dissected free clamped in two places and divided This must be done as near to the spleen as convenient in order to avoid injury to the vasa brevia branches going to the fundus of the stomach Care must be taken throughout to define the pancreatic tail and avoid its inclusion in any ligature The next step is to clamp divide and ligate the splenic veins. Finally the gastrosplenic fold of peritoneum is divided and the spleen is free

Removal of a ruptured normal spleen or of an ectopic organ is as simple as the above description suggests Ablation, however of a greatly enlarged spleen may present considerable difficulty not only because of the adhesions already mentioned but from the number size and fragility of the splenic veins which bleed furiously upon the least provocation. In such difficult cases the first step must always be to attempt to separate the spleen from the diaphragm, for if this is impossible splenectomy cannot be performed. It is wise in every operation of this nature to have a flask of compatible blood in the theatre ready for immediate transfusion.

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CHAPTER XXXV

THE KIDNEY AND URETER

SURGICAL *Anatomy of the Kidneys*—The kidneys two in number lie behind the peritoneum on either side of the vertebral column Each measures 4 in. in length 2½ in. in breadth and 1¼ in in thickness. Their position is variable as they move with respiration, but they extend from the level of the upper border of the last dorsal vertebra to the middle of the body of the third lumbar vertebra the left being slightly higher than the right. Their weight is about 5½ oz. Each presents an anterior and a posterior surface and an upper and lower pole The surfaces are smooth and glistening being covered with the renal capsule The outer border is convex and the inner concave, receiving as it does the renal vessels and the renal pelvis. The upper pole is rather larger and more rounded than the lower In life the organ is movable and expansile and shows none of the visceral markings described by anatomists

Relations.—(1) *Anteriorly* the right kidney is in contact with the right suprarenal gland, liver duodenum hepatic flexure of the colon and peritoneum which separates it from the small intestine The left kidney is in contact with the left suprarenal gland spleen, stomach pancreas splenic flexure of the colon and peritoneum. (2) *Posteriorly* the relations are similar on the two sides The inner half rests on the crus of the diaphragm and the psoas magnus muscle and the outer half on the 12th rib diaphragm and the quadratus lumborum muscle The last dorsal nerve with the ilio-inguinal and ilio-hypogastric branches of the 1st lumbar nerve pass posterior to the kidney The pleura lies behind the kidneys, the diaphragm intervening (3) *Superiorly* the suprarenal gland caps each kidney (4) *Externally* the kidneys lie against the anterior layer of the transversalis aponeurosis, and at its upper margin the right touches the liver and the left reaches the spleen. (5) *Internally* the hilum is a longitudinal fissure with thick rounded lips leading to the renal sinus. It transmits the branches of the renal vein, renal artery and the pelvis in that order from before backwards.

Perirenal Capsules.—The kidneys are embedded in a cushion of tough fat which is continuous with the subperitoneal fat The whole is surrounded by a dense fascia—the fascia of Zuckerkandl. This arising from the transversalis aponeurosis in the loin, sends a strong anterior layer in front of the kidney which is continuous with the fascia over the opposite kidney Its posterior layer passes behind the kidney and is attached to the vertebral bodies Above it forms a separate compartment for the suprarenal gland below the two layers do not fuse with each other

The Renal Pelvis is the funnel-shaped expansion of the ureter and in the renal sinus it divides into two main sections, from which the calyces spring

The Renal Artery divides into two branches passing one in front and the other behind the pelvis In this way the kidney is supplied by an anterior and posterior group of arteries, which remain independent As a result a line of demarcation exists between the two sets of vessels, the so-called *bloodless line of Hyrtl*, parallel to and just behind the outer

border An additional renal artery is present in about 20 per cent. of people. The lymphatic drainage is into the glands lying in front of and between the aorta and the vena cava at the level of the renal arteries.

Internal Structure.—The cut surface shows two layers—cortex and medulla The medulla surrounds the renal sinus and forms the pyramids. The apex of each of these ends by coalescing with several of its neighbours to form a papilla, which projects into a minor calyx. The number of these varies from six to fourteen. The cortex is thinner and of a different pattern and covers the medulla sending columns between the pyramids. Several minor calyces unite to form a short, broad major calyx of which there are usually two or rarely three These unite to form the renal pelvis.

Surgical Anatomy of the Ureter.—The ureter passes downwards and slightly inwards on the posterior abdominal wall behind the peritoneum, to which it is so closely attached that if the latter is dissected up the ureter will remain adherent to it It lies on the psoas muscle is crossed anteriorly by the spermatic or ovarian vessels, while the genito-crural nerve passes behind it. It enters the pelvis by crossing obliquely over the bifurcation of the common iliac artery the right ureter being here crossed by the root of the mesentery and the left by the mesosigmoid. In the pelvis it passes round the outer wall beneath the peritoneum, crossing the obturator vessels and nerve and the obliterated hypogastric artery In the male it is crossed by the vas deferens, and in the female by the base of the broad ligament and the uterine artery It passes over the lateral fornix of the vagina in close relation to the cervix uteri. It enters the bladder by traversing the wall obliquely The ureter has three narrowings in its lumen, viz., at the ureteropelvic junction, at the pelvic brim and at its entrance into the bladder It measures 12 in. in length its intramural vesical part being ¾ in. long and the two orifices between ¾ and 1 in. apart.

Examination of the Urinary Tract.—Modern methods have transformed the diagnosis of urinary diseases to an exact science the following sets out the technique of a complete urological investigation.

1 Inspection.—The stigmata of failing renal function are easily recognisable The tongue is dry red and glazed, and later brown and furred the face has the earthy colour of toxæmia rather than the pallor of anæmia the skin is dry and coarse the hair is dry lustreless and fragile the pulse is rapid, full and bounding and increased in tension. Patients complain of thirst headaches loss of appetite and nausea Locally only very large tumours are apparent in the loin

2. Palpation.—A normal kidney cannot be felt in normal people, unless they are very thin, but if it is enlarged or unduly mobile it is easily examined except in very fat subjects. The patient lies on the back, with the thighs flexed, and the surgeon sits by the affected side (for purposes of description, the right side) His left hand is placed behind the patient with the little finger along the iliac crest and the index finger along the lower border of the last rib, the finger tips resting against the outer edge of the erector spinæ muscle The right hand is placed on the front of the abdomen along the costal margin with the finger tips reaching the edge of the rectus abdominis muscle The kidney can thus be examined bimanually The characteristics of a renal swelling are

(a) It moves on respiration
(b) It can be felt bimanually
(c) It comes from under the costal arch fills out the loin and spreads downward to the iliac fossa of the same side and never diagonally toward the umbilicus

(d) It can be reduced beneath the costal arch and if not very large slips from between the hands in a characteristic way
(e) Renal ballottement can be obtained by pressing the tumour backwards with the anterior hand.
(f) It may or it may not have a vertical band of resonance across it but it never has a resonant area outside it

Renal swellings have to be distinguished from
A On the right side An enlarged gall bladder a Reidel s lobe of the liver other liver swellings, a mass in the colon, duodenum, pylorus pancreas or suprarenal gland
B On the left side An enlarged spleen, a mass in the left lobe of the liver stomach colon, pancreas or suprarenal gland.

3 **Renal Pain.**—In kidney disease there are four types of pain (a) *Local renal pain* is situated deep in the loin is somewhat diffuse and is described by patients as in the back in the abdomen or deep in the side The centre of the area is the costo-lumbar angle behind (i.e., where the last rib meets the erector spinæ) and the tip of the 9th costal cartilage in front. (b) *Referred pain* is felt over the whole or part of the area supplied by the last dorsal nerve and the ilio-inguinal and ilio-hypogastric branches of the 1st lumbar nerve that is, down the inguinal canal to the scrotum or labium majus, over Poupart s ligament to Scarpa s triangle and over the iliac crest to the upper part of the buttock. It is never referred upwards to the shoulder or scapula. (c) *Renal colic* is an agonising pain with periodic exacerbations felt in the kidney area and along the line of the ureter (d) *Pain in the opposite kidney* is not reflex pain but is produced by tension within the kidney due to its unyielding capsule When the functional activity of one kidney is impaired additional strain falls upon the other which has to increase its normal work. In time in young people it will hypertrophy to twice its normal size but until then an intense hyperæmia is produced, which will lead to increased renal tension These four types of pain in renal disease will be referred to repeatedly later but will not again be described in full.

Examination of the Urine.—The urine is examined for changes in its specific gravity in its twenty four hour quantity and for any abnormal constituents In surgical practice the urine will be tested in ALL cases, not only in those in which the disease is urinary in origin. In women only a catheter specimen provides true evidence

1 **Polyuria,** when continuous, is seen in many conditions in which there is a gradual destruction of renal tissue, and in these while the actual quantity is increased the constituents are diminished. In nervous polyuria no change in renal function is found

2. **Oliguria** is a diminution, and **Anuria** a total cessation of the secretion of urine Thompson Walker classifies anuria as follows (a) hysterical anuria (b) anuria due to changes in blood pressure (c) reflex anuria (d) infective anuria, the infection being either blood borne or ascending from the bladder (e) tension anuria due either to obstruction or to its too-sudden relief

3 **Albuminuria.**—Albumen alone is rarely a sign of surgical renal disease but it may have a marked influence on surgical conditions. If found in a patient before operation, a general overhaul is necessary to ascertain its cause This may lead to the abandonment of a non urgent operation or to the adoption of special technique in an emergency

4 **Glycosuria.**—Sugar is present in the urine in certain surgical conditions e.g carbuncles, diabetic gangrene certain intracranial lesions etc. It will

border An additional renal artery is present in about 20 per cent. of people. The lymphatic drainage is into the glands lying in front of and between the aorta and the vena cava at the level of the renal arteries.

Internal Structure.—The cut surface shows two layers—cortex and medulla. The medulla surrounds the renal sinus and forms the pyramids. The apex of each of these ends by coalescing with several of its neighbours to form a papilla which projects into a minor calyx. The number of these varies from six to fourteen The cortex is thinner and of a different pattern and covers the medulla, sending columns between the pyramids. Several minor calyces unite to form a short, broad major calyx, of which there are usually two or rarely three These unite to form the renal pelvis.

Surgical Anatomy of the Ureter.—The ureter passes downwards and slightly inwards on the posterior abdominal wall behind the peritoneum to which it is so closely attached that if the latter is dissected up the ureter will remain adherent to it It lies on the psoas muscle, is crossed anteriorly by the spermatic or ovarian vessels, while the genito-crural nerve passes behind it. It enters the pelvis by crossing obliquely over the bifurcation of the common iliac artery the right ureter being here crossed by the root of the mesentery and the left by the mesosigmoid In the pelvis it passes round the outer wall beneath the peritoneum, crossing the obturator vessels and nerve and the obliterated hypogastric artery In the male it is crossed by the vas deferens and in the female by the base of the broad ligament and the uterine artery It passes over the lateral fornix of the vagina in close relation to the cervix uteri. It enters the bladder by traversing the wall obliquely The ureter has three narrowings in its lumen viz. at the ureteropelvic junction, at the pelvic brim and at its entrance into the bladder It measures 12 in. in length its intramural vesical part being ¾ in long and the two orifices between ¾ and 1 in apart.

Examination of the Urinary Tract.—Modern methods have transformed the diagnosis of urinary diseases to an exact science the following sets out the technique of a complete urological investigation.

1 Inspection.—The stigmata of failing renal function are easily recognisable The tongue is dry red and glazed and later brown and furred the face has the earthy colour of toxæmia rather than the pallor of anæmia the skin is dry and coarse the hair is dry lustreless and fragile the pulse is rapid full and bounding and increased in tension. Patients complain of thirst headaches loss of appetite and nausea. Locally only very large tumours are apparent in the loin

2 Palpation.—A normal kidney cannot be felt in normal people, unless they are very thin, but if it is enlarged or unduly mobile it is easily examined except in very fat subjects The patient lies on the back, with the thighs flexed and the surgeon sits by the affected side (for purposes of description, the right side) His left hand is placed behind the patient with the little finger along the iliac crest and the index finger along the lower border of the last rib the finger tips resting against the outer edge of the erector spinæ muscle The right hand is placed on the front of the abdomen along the costal margin with the finger tips reaching the edge of the rectus abdominis muscle The kidney can thus be examined bimanually The characteristics of a renal swelling are

(a) It moves on respiration.
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4 **Glycosuria.**—Sugar is present in the urine in certain surgical conditions e.g carbuncles diabetic gangrene certain intracranial lesions, etc It will

example it is important to know the total efficiency of both kidneys, in order that the correct treatment may be determined In both groups a serious operation is contemplated which will throw a great additional strain on renal function. It is evident therefore that the importance of these tests lies not in their indication of the work done by a kidney or kidneys under normal conditions but in their expression of renal adaptability to sudden strain. By such a criterion should all tests be judged

The tests are —

A Tests of retention, *i.e* of substances in the blood.
B Tests of excretion, *i.e.* of substances normally in the urine or of a foreign drug specifically administered
C A combination of the two

A **Tests of Retention.**—The urea concentration in the blood is the best of the retention tests. The normal amount varies between 15 and 40 mg of urea in 100 c.c of blood Sixty milligrams indicate a negligible retention, but beyond that figure a danger signal has been shown.

B **Tests of Excretion.**—Tests of the urine require that, if the function of one kidney only is being tested its urine must be collected separately by ureteric catheter The concentration of urea in the urine provides an excellent test but is misleading unless properly carried out The technique is as follows In the evening of the day before the test the patient is given a light meal at 6.30 P.M., after which no food is allowed until the test is completed. The next morning at 7 A.M. 15 grm. of urea are given by mouth with a draught of water At 8 A.M. the bladder is emptied and this urine is discarded (because it is the result of the diuretic effect of the urea) and then specimens are collected at 9 and at 10 A.M. and examined for the amount of urea. In this way the kidneys have been subjected to a sudden overload and an indication is given of their capabilities under stress. In normal urine there is about 2 per cent. urea but under the conditions of the test healthy people will secrete 4 per cent or even more A reading under 3 per cent is a danger signal.

Dye tests have been popular methylene blue indigo carmine rosanilin, phloridzin and phenolsulphonephthalein having been extensively used They are injected intravenously and the times of their first appearance their maximum intensity of secretion and their total excretion are noted. They may serve some minor function in urology but they must be regarded as inadequate tests of surgical renal efficiency

The method of choice lies in the combination of the urea concentration tests in both blood and urine They have been grouped together under the term the urea clearance test," and this affords the most reliable guide But a general clinical examination of the patient must always remain the determining factor in the making of a difficult decision

CONGENITAL ANOMALIES OF THE KIDNEY

These may be —

A In number—either excess or deficiency
B In shape—either fœtal lobulation or fusion variations.
C In position—either abdominal or pelvic
D In mobility
E In blood supply

An additional kidney is very rarely seen, and most supposed cases are deformities of development of one kidney Total absence of both

kidneys means the production of a dead monster Absence of one kidney is rare and a more common anomaly is the presence of an imperfect kidney with maldeveloped vessels and ureter Such a kidney may be represented by a mere mass of fibrofatty tissue or some renal tissue without glomeruli may be present the ureter may exist but not be patent or it may be but a small remnant attached to the bladder A solitary kidney is hypertrophied and may have a double ureter opening into the same side of the bladder Such examples illustrate the need for a complete urological investigation before planning a nephrectomy

Fœtal lobulation is an arrest of development just short of perfection, the kidney substance and function being normal. **Fusion variations** imply union between the two kidneys a condition known as horseshoe kidney The connecting band of renal tissue is usually between the lower poles (Fig 362) occasionally at the upper poles and rarely at the middle There are two distinct pelves with ureters crossing in front of the connecting link. The band of tissue passes in front of the aorta and vena cava The renal function will be normal but the fusion causes some difficulty in the technique of dealing with disease on one side



FIG. 362

The convex border of the horse-shoe connection between the two kidney can be seen A stone is present low down in the right ureter

Misplaced kidneys to be truly a congenital anomaly must have their vascular supply derived from an unusual origin otherwise they are merely abnormally mobile In abdominal misplacements they are probably normal in shape and size but placed too high too low or too near the midline In the pelvic type they are spherical not reniform and usually lie between the common iliac arteries from one of which arises the renal artery

Abnormal branches of the renal artery are common, the best known example being that which leaves the main trunk early and passes downwards and outwards to the lower pole in doing so it may kink the ureter and lead to hydronephrosis

Coexisting malformations are often seen in the genital tract of both sexes *e.g* imperfect descent or abdominal retention of the testis, anomalies of the uterus and vagina or absence of the ovary and tube on the same side

ANOMALIES OF THE URETER

Double ureters are common. They may be separate in their whole length with two openings into the bladder and two separate pelves

they may arise from two distinct pelves and fuse at once or they may unite at any part of their course (Fig 363) Occasionally a ureter of one side will cross the middle line and enter the opposite side of the bladder It may open extravesically into a seminal vesicle or ejaculatory duct Errors in canalisation of the original solid tube may lead to congenital strictures or to valve-like folds of mucous membrane which may later produce hydronephrosis



FIG. 363

A kidney having a double pelvis and double ureter This specimen shows an early degree of hydronephrosis with obliteration of the pyramidal cups.

Surgical Significance —Many of these anomalies pass undetected to the grave but rare as they are they occasionally produce surgical tragedies. So exact are the methods of renal investigation that there can be no acceptable excuse for the removal of a solitary kidney It has also been said that the abnormally developed kidney is more prone to disease than the normal. No *proof of such statement can* be produced.

MOVABLE KIDNEY OR NEPHROPTOSIS

The kidneys have a normal respiratory movement of 2 in Beyond this they are abnormally mobile and Glénard has described four grades of mobility

1 When the lower pole } of the kidney is palpable on inspiration.
2 When the greater part } of the kidney is palpable on inspiration.
3 When the whole } of the kidney is palpable on inspiration.
4 When the kidney is palpable without respiratory aid This last degree is also called a *floating kidney*

The kidneys move with respiration in the fascial sac of Zuckerkandl, which is open below The perirenal fat moves with the kidney and such small fibres as do run from the perirenal capsule to the kidney are quite inadequate to maintain the latter in position nor has the peritoneum any influence There is thus no anatomical structure which can have a direct action in holding up the kidney The chief factors are the abdominal musculature the maintenance of normal fat content in the retroperitoneal space and a normal body form

Etiology —Movable kidney is more common in women (10 to 1) on the right side (15 to 1) and occurs most often between the ages of 25 and 50 It may be congenital in rare instances but is usually acquired The causes are not known but there are many predisposing

factors There are well recognised types of body form, each with its varying details of anatomical structure of thorax and abdomen Among these the typical visceroptotic form combined with an atonic abdominal musculature will allow prolapse of the kidney Scoliosis child birth, a sedentary life rapid wasting from disease, and the removal of large tumours all predispose to a dropped kidney There is no evidence that injury has any etiological significance

Pathology —The kidney is normal in shape and size unless it has become hydronephrotic. The vascular pedicle is lengthened but as it must retain its attachment to the aorta and vena cava the moving kidney has to travel in the arc of a circle and some axial rotation will occur In some cases the ureter may be so securely attached to the peritoneum that kinking occurs and obstruction follows In no instance does the suprarenal gland follow the kidney in its movements

Symptoms —The extent of the mobility has no bearing on the symptoms which in the great majority of cases are absent When present they are renal, gastro-intestinal and nervous The patient complains of indefinite pain or a sense of dragging in the loin, which may be increased by standing exertion or during menstruation. If the ureter becomes kinked, severe attacks of pain occur which are known as *Dietl's Crisis* The pain is sudden in onset, very acute, colicky in nature and accompanied by nausea or vomiting The attacks cease as abruptly as they started The gastro-intestinal symptoms are those of visceroptosis in general and of the underlying neurasthenia. In the nervous disturbances cause and effect are in distinguishable and the knowledge that a kidney is unduly movable is certain to accentuate the symptoms.

Treatment is directed towards the removal of any predisposing factor Exercises to develop the weak muscles or remedy a scoliosis and careful dieting to increase the weight are useful. The first essential is to allay any fears as to the presence of cancer The diagnosis should never be mentioned but the cause of the underlying neur asthenia must be investigated Belts are to be avoided completely Operation should be reserved for those patients in whom a pyelogram shows a definite hydronephrosis In these cases operation (nephropexy) is necessary to preserve the function of the kidney but apart from this surgery is not justified.

INJURIES OF THE KIDNEY

Etiology —Injuries are uncommon over 90 per cent occurring in men. The right side is affected more frequently than the left Bilateral injuries are very rare indeed. They are produced by direct violence such as blows or kicks in the loin, by crushing in run-over or compression in buffer accidents and by indirect violence in severe muscular contractions.

Pathology —The degrees of damage are —

1 Tears of the fatty capsule with a perirenal hæmatoma
2 Subcapsular contusions in which the blood is later absorbed

3 Interstitial rupture of the kidney parenchyma with or without tears of the capsule Such tears radiate from the capsule and are chiefly on the anterior surface
4 Such tears may extend into the pelvis with resulting extravasation of blood and urine
5 Complete fragmentation of the kidney and
6 Associated tear of the peritoneum which is very rare and more often seen in children

Spontaneous healing will occur in the first two groups and in some cases in the third but early surgical intervention will be needed in the others Infection may follow in all types.

Symptoms are shock pain the formation of a hæmatoma hæmaturia and other changes in the urine Shock is severe but depends more upon the general effects of a major injury than upon the actual renal damage Pain is both renal and referred whilst there is also associated pain due to local brui ing of the abdominal and thoracic walls and possibly to other lesions such as fractured ribs Renal colic may follow from the passage of clots Hæmaturia is almost constant but varies greatly in amount A renal hæmatoma may be felt in the loin within two hours of a serious rupture or it may take several days to become palpable The tumour so formed will not move on respiration. Later bruising of the skin may be seen at the external abdominal ring and in the scrotum In some cases the bleeding may be so severe that the symptoms and signs of internal hæmorrhage rapidly appear and death may result Oliguria follows most severe renal injuries, and should there be only one functioning kidney anuria is likely to result During healing a polyuria succeeds the oliguria.

Treatment—Many renal injuries will recover spontaneously while others will die unless operated upon immediately The shock will demand appropriate treatment at the beginning and after forty-eight hours the degree of injury should be clear Slight cases should be watched for a few days All cases of hæmaturia without hæmatoma may be safely treated by rest in bed and careful nursing for fourteen days after the bleeding has ceased A hæmatoma large enough to be felt should be operated upon because even if the renal injury is slight the danger of infection is too serious to risk.

Severe retroperitoneal hæmorrhage intraperitoneal bleeding and extravasation of urine demand immediate operation as the prognosis rapidly becomes hopeless

Procedure at operation will depend upon the degree of injury and in many cases a nephrectomy will be the only proper course whenever possible the kidney should be saved and tears in its substance capsule or pelvis sutured

Injuries with External Wound.—Such injuries are rare even in war They may be due to stabs with swords bayonets or knives and wounds by bullets or shell fragments There are usually coexisting injuries of other organs and in large wounds the kidney may completely or partially prolapse Two factors are of importance viz the external leakage of urine and the high percentage of infected wounds. The

symptoms are similar to those in the subparietal lesions except that there will be a resultant urinary fistula in some cases Perirenal collections of urine and blood are unlikely unless the track is narrow and tortuous

The uninfected wound without urinary leakage will probably heal spontaneously In general the treatment will be that of the *wound itself removal of any foreign body and suture of the torn* kidney and pelvis or removal of the organ if irremediably injured. If prolapsed it should be sutured in position before the wound is closed

HYDRONEPHROSIS

An incomplete obstruction, which is gradual or intermittent to the outflow of urine from one kidney produces a distension of the pelvis and calyces known as a hydronephrosis Sudden complete blockage causes atrophy of the kidney with little distension.

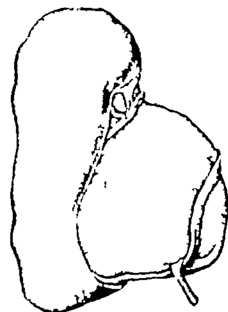


Fig. 361
A pelvic hydronephrosis due to aberrant renal artery

Etiology—It may be seen at any age being more common in women and on the right side If the obstruction is confined to one ureter the hydronephrosis is unilateral but both kidneys are affected when either the prostate or urethra is the seat of obstruction. A partial hydronephrosis results from the blockage of one major calyx (Fig 381 p 777)

Causes of Unilateral Hydronephrosis are congenital and acquired CONGENITAL LESIONS are chiefly due to errors of development at the ureteropelvic junction, leading to a stricture or to the formation of a fold of mucous membrane which acts as a valve An aberrant renal artery which arises from the main vessel just after its origin and enters the lower pole of the kidney may kink the ureter and obstruct the outflow of urine (Fig 364)

THE ACQUIRED VARIETY has many causes The lumen of the ureter may be blocked by a stone a growth of the renal pelvis foreign bodies or blood clot Its wall may be narrowed by a stricture of infective traumatic or neoplastic origin and it may be compressed by tumours from without such as the pregnant uterus and carcinoma of the uterus or rectum The abnormally movable kidney is an occasional cause of kinking of the ureter A certain number of well-developed hydronephroses have no apparent cause and it is believed that they are due to a defect in autonomic

neuromuscular control leading to intermittent spasm of the ureteropelvic junction

Causes of Bilateral Hydronephrosis are found in the bladder and urethra and include vesical calculi growths of the bladder benign and malignant enlargements of the prostate stricture of the urethra, carcinoma of the penis phimosis and "pin hole meatus Very rarely valvular deformities or stricture of the urethra of developmental origin are responsible

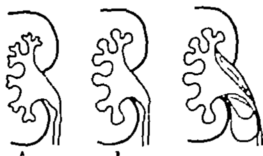


Fig 365

A diagram illustrating the progressive stages in the formation of a hydronephrosis.

A, is the normal appearance, each calyx being cupped; B, shows the obliteration of the cups; and in C the dotted lines indicate the progressive bulging of the pelvis itself

Pathology—The earliest change is obliteration of the protrusion of the pyramid into the calyx, which instead of being cupped becomes rounded or clubbed next there is a dilatation of the calyces and later a gradual distension of the pelvis which is first shown by a flattening out of the normal regular curve made by the outer wall of the ureter and the lowest calyx (Fig 365) This stage is called a *pelvic* hydronephrosis Eventually the renal parenchyma atrophies and the whole kidney distends and becomes lobulated this being a *renal* hydronephrosis (Fig 366) In moderate degrees of distension either of these two varieties may predominate

Symptoms—There are two clinical types viz. the closed and the open or intermittent The **Closed** may have no symptoms or at most a dull aching pain in the loin until a cystic tumour of renal origin can be recognised.



Fig. 366

A drawing illustrating the two types of hydronephrosis: the pelvic P and the renal R

The **Intermittent** type is the more common It is important that the condition should be recognised before the renal parenchyma has suffered any damage so that the function of the kidney may be preserved.

In the pre Tumour Stage the picture may be confused by a history attributable to the cause of the condition. The only symptom of the hydronephrosis is pain of renal type which comes on in periodic attacks A physical examination is negative and the urine is normal Every patient who has renal pain and a normal urine should be

suspected of having an early hydronephrosis and a pyelogram taken (Figs. 367 370)

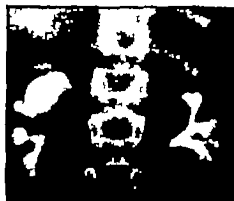


FIG. 367

A bilateral ascending pyelogram illustrating a congenital hydronephrosis of the right kidney due to a developmental defect at the uretero-pelvic junction.



FIG. 368

A pyelogram of left kidney showing a hydronephrosis due to aberrant renal artery. Failure to recognise its presence led to persistence of a *B coli* pyelitis in spite of treatment.

The Tumour Stage is characterised by recurrent attacks of pain, during which the patient is conscious of the gradual appearance of a tumour in the loin and of a diminished output of urine The pain ceases and after a time there is a copious polyuria accompanied by subsidence of the tumour A pyelogram will confirm the diagnosis

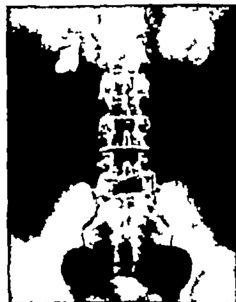


FIG. 369

An intravenous urography showing the appearance of a renal type of hydronephrosis of the left kidney

Treatment —The underlying cause must be dealt with and in the early cases nothing else is required. In later stages plastic operations on the large flabby pelvis should be done to prevent retention of urine within it. A nephrectomy should not be performed unless the kidney is so destroyed that its function has become of no value Those rare examples of sympathetico-renal tonus (Harris) are treated by stripping the renal pedicle thereby severing the sympathetic nerves.

PRIMARY RENAL ARTERIAL HYPERTENSION

Recent work has proved that a small number of cases of hyper

tension are due to damage to one kidney such trauma is usually to the vessels It is believed that the devitalised renal tissue develops a nephrotoxin which leads to a high blood pressure A recent case of the author s illustrates this condition A young man suffering from hydronephrosis was operated upon and an aberrant vessel going to the lower pole divided. All symptoms due to the hydronephrosis disappeared but within a few weeks the blood pressure was found to be over 200

Although such cases are rare ligature of branches of the renal artery must be abandoned in future and suitable plastic operations substituted. The only treatment for the established condition is nephrectomy

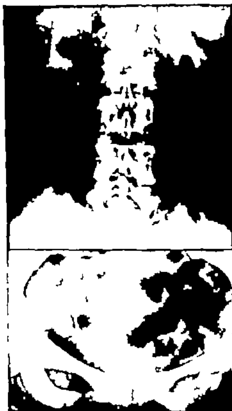


FIG. 370

A composite picture showing the great distension of the right ureter with a minor degree of pelvic hydronephrosis due to a ureterovaginal fistula.

ACUTE INFECTIONS OF THE KIDNEY

Acute Pyelitis

Acute Primary Hæmatogeneous Renal Infection is one of the commonest diseases met with in practice and at the same time one misdiagnosed more frequently than most

Etiology —Renal infections are very common in both sexes a fact which should cause little surprise when it is recalled that the kidney is an organ of excretion and organisms circulating in the blood will pass through the renal tubules The condition is seen in patients of all ages from infancy upwards In the first and second decades it is equally distributed between the sexes but after the twentieth year it affects females more than males The greater liability of the female to constipation and the contiguity of her external genital organs to the anal region suffice to explain this incidence The right kidney is more often affected than the left but in many patients the infection is bilateral.

The infecting organisms are chiefly aerobic being in order of frequency members of the coli group *Staphylococcus aureus* and *albus* *Bacillus proteus* streptococci of various strains occasionally other *intestinal bacteria* and very rarely pneumococcus and gonococcus The paths of invasion are either by the blood stream from the bladder

below or via the lymphatics The portals of entry are often impossible to define Constipation, appendicitis gastro-enteritis cholecystitis and in women tears of the hymen perineum and cervix may provide an opportunity for the absorption of coli organisms Staphylococcal infections are usually derived from comparatively trivial skin lesions such as boils and carbuncles The ascending type of infection from the lower urinary tract may give rise to pyelitis on one or both sides but it is unlikely to occur unless there is some obstruction to the ureters or urethra. It is possible, though unlikely that the right kidney may be infected by lymphatic spread from the cæcum.

Certain *accessory factors* play a considerable part in both the onset and duration of renal infections The danger of an ascending pyelonephritis in cases of enlargement of the prostate and of stricture is well known but an early unilateral hydronephrosis may be unsuspected at the onset of an acute pyelitis and be the cause of an unexpected failure in treatment Any of the many causes of hydronephrosis may be found at operation. The slight degree of compression of the ureters by the gravid uterus explains the liability of pregnant women to pyelitis

Pathology—Acute infections of the kidney are invariably referred to as acute pyelitis a term firmly established by long usage It is however somewhat misleading for the inflammatory reaction is not confined to the pelvis and there is a round-celled infiltration in the renal parenchyma and later minute areas of focal necrosis

Symptoms—There is likely to be an initial stage of weariness and lassitude of which the patient thinks nothing It will last not more than thirty-six hours The classical symptoms are (1) pain, (2) vomiting (3) rigors (4) pyuria (5) high fever (6) frequent and painful micturition, (7) headache

Pain is renal in type It is felt deep in the loin and is described as being in the back at the costo-lumbar angle and in the front of the abdomen below the costal margin It may also be referred to the usual areas i.e downwards and forwards into the groin and scrotum or labium majus and over Poupart's ligament into Scarpa's triangle Vomiting usually occurs as an initial attack with the onset of the pain and is rarely continued beyond the first two hours Rigors are so constant a feature that they are to be regarded as pathognomonic. Pus is always present in the urine but it must be clearly understood that during the first twenty-four or forty-eight hours the quantity may be so small that it is difficult to demonstrate by chemical tests and a microscopic examination will be needed in most cases

High fever is characteristic the temperature rising abruptly to 105° F in severe cases Frequent and painful micturition does not appear till the second or third day and is never a really prominent symptom

Headache is present in every patient in a more or less mild degree but occasionally it becomes so severe as to be the predominant feature. The clinical picture varies considerably according to the severity of the infection and three types are described.

1 **Acute fulminating pyelitis** has so severe and sudden an onset that it may be mistaken for the perforation of a peptic ulcer The pain is excessive the temperature rises to 105° F and there will be one or more rigors Bimanual palpation of the renal area reveals tenderness and rigidity of the muscles of the loin.

2 **Acute pyelitis** is of less intensity and of more gradual onset and is liable to be mistaken for acute appendicitis The pain is less severe the temperature rises to 103 F and rigors are present There is tenderness in the loin but little rigidity

3 **Subacute pyelitis** gives mild pain no vomiting no rigidity and a temperature of 101 F Rigors are slight and transient and pus is found in the urine in considerable quantity from the beginning

Diagnosis—(*A*) Right-sided pyelitis has to be distinguished from the perforation of a peptic ulcer which is characterised by low temperature slow pulse and more widespread tenderness and rigidity from acute appendicitis in which the pain begins centrally around the umbilicus and later travels to the right side the temperature rarely reaches the height of pyelitis and there is never a rigor from acute cholecystitis and gall-stone colic in which the previous history and the physical signs are quite different Other lesions of the right kidney such as calculus hydronephrosis and Dietl s crisis may exhibit equally severe pain but these conditions are not inflammatory (*B*) Left-sided pyelitis gives rise to less confusion acute diverticulitis intestinal obstruction torsion of an ovarian cyst and other diseases of the left kidney being possible sources of error

Treatment.—The treatment of urinary infections has been entirely revolutionised by chemotherapy

Sulphadiazine is given in the following doses —

First day an initial dose of four half-gram tablets followed by two tablets four hourly which later dose is continued until the end of the fifth day On the sixth and seventh days two tablets are given three times a day Patients must be warned of the importance of taking at least four pints of fluid in each twenty four hours to avoid the danger of crystallisation of the drug within the renal tubules.

Penicillin is of no value in urinary infections unless the organisms are sensitive which is not usually the case

Some patients cannot tolerate this group of drugs and for them treatment by ketosis obtained either by a ketogenic diet or mandelic acid will prove equally successful. The latter gives many people nausea and the former is not easy to prepare nevertheless these two methods must be thoroughly understood and used in all patients who cannot tolerate sulphadiazine or who are not improving on it Details of both can be found in textbooks of medicine

The Acute Pyelitis of Pregnancy differs in no way from the condition described above In spite of the pressure of the uterus on the ureters treatment relieves the symptoms if not the bacilluria

The Acute Pyelitis of Children is seen in both sexes and there is often a history of recent gastro-intestinal disturbance The attack is

below or via the lymphatics The portals of entry are often impossible to define Constipation appendicitis gastro-enteritis cholecystitis and in women tears of the hymen perineum and cervix may provide an opportunity for the absorption of coli organisms Staphylococcal infections are usually derived from comparatively trivial skin lesions such as boils and carbuncles The ascending type of infection from the lower urinary tract may give rise to pyelitis on one or both sides but it is unlikely to occur unless there is some obstruction to the ureters or urethra It is possible though unlikely that the right kidney may be infected by lymphatic spread from the cæcum

Certain *accessory factors* play a considerable part in both the onset and duration of renal infections The danger of an ascending pyelonephritis in cases of enlargement of the prostate and of stricture is well known but an early unilateral hydronephrosis may be unsuspected at the onset of an acute pyelitis and be the cause of an unexpected failure in treatment Any of the many causes of hydronephrosis may be found at operation The slight degree of compression of the ureters by the gravid uterus explains the liability of pregnant women to pyelitis

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usually severe and follows the typical course as described above It is emphasised here as its existence in children is not sufficiently realised and the diagnosis may be delayed on that account Children respond well to sulphadiazine as well as to the ketogenic diet if facilities exist for its provision The pH may fall even to 4 8 in children under ten years of age

Acute Pyelonephritis (acute secondary ascending renal infection) is usually bilateral. It is secondary to disease in or distal to the bladder *e.g* pelvic and puerperal infections in women and enlarged prostate and urethral stricture in men. The infecting organisms are usually staphylococci or streptococci. It is therefore a complication of pre-existing disease and only too frequently marks the closing scene of life

Symptoms—During the course of some other disease either spontaneously or after instrumentation or operation, the patient suddenly has a rigor and the temperature rises steeply to 104 or 105 F There is pain in both loins nausea and drowsiness The tongue is dry and furred and the abdomen distended. The secretion of urine is diminished or abolished. In the worst cases delirium and coma rapidly usher in a fatal issue while in others after some days of extreme anxiety the flow of urine is re-established and the condition subsides leaving permanently damaged kidneys

Treatment should be prophylactic and no surgical interference carried out until the renal function has been estimated. Active drainage must be obtained by suprapubic cystotomy done under a local anæsthetic, and a constant intravenous drip of 5 per cent solution of sodium sulphate and 10 per cent glucose in normal saline given.

Catheter Fever or Urethral Chill.—Sometimes after the passage of a urethral bougie or catheter patients have a rigor and a rise of temperature The time which elapses after instrumentation and the severity of the attack vary greatly This condition is due to a temporary recrudescence of a renal infection as a result of urethral interference Such attacks when first experienced are an indication for a routine urological investigation for mild recurrent cases instrumentation should be followed by the administration of quinine sulphate (gr v) by the mouth

Pyonephrosis.—A distension of the pelvis and kidney with pus may be due to infection of a previously existing hydronephrosis the result of a slowly progressing pyelonephritis or the terminal stage of renal tuberculosis

Pathology—The infecting organisms are *Bacillus coli* staphylococci or streptococci. Superimposed on the antecedent condition there is a distension of the kidney and pelvis with pus and the perinephric fat is adherent infiltrated and œdematous The lining of the cavity is in the later stages a thick walled pyogenic membrane A partial pyonephrosis may occur when one calyx only is distended and infected.

Symptoms—Pain is constant severe and renal in type The urine contains pus in varying amounts and in some of the more chronic cases there will be attacks of retention in the affected kidney

when the urine will be clear and free from pus The patient may be aware of a swelling in the loin and this can always be felt on palpation The general condition is poor and there is a febrile swinging temperature Cystoscopy will reveal a purulent efflux from the affected ureter unless the pyonephrosis be closed in which case massage of the loin may produce a discharge of thick creamy pus resembling the appearance of tooth paste from a collapsible tube

Treatment —Nephrotomy and drainage are the first essentials and if the cause of the obstruction is easily reached, it should be dealt with, *e.g* the removal of a calculus In many severe cases a rapid nephrotomy alone is possible and more radical measures are delayed until the general condition has improved Later nephrectomy may be needed if the kidney fails to recover

Perinephritis.—The sclerosing type of fibrolipomatous perinephritis is seen in a mild degree in every case of renal infection, whatsoever the cause The thickened fibrous fat is adherent to the kidney and gives no symptoms. In some patients, notably those with a long-standing calculous pyonephrosis a large tumour is formed

Perinephric Abscess.—*Etiology* —There are two forms primary and secondary **Primary** may result from infection of a hæmatoma following injury to the kidney but is more often seen in connection with trivial skin infection *e.g* boils, and is invariably staphylococcal It is more frequent in men, on the right side and in the active years of adult life The infection is carried by the blood stream and deposited in the fat or more probably the glomeruli of the kidney filter off the organisms, and a small subcapsular abscess develops This bursts through the renal capsule and pus enters the perinephric fat

Secondary abscesses occur as complications of other inflammatory diseases such as appendicitis cholecystitis salpingitis liver abscess and empyema. A chronic tuberculous perinephric abscess may result from disease of the vertebral column, ribs or pelvis.

The abscess may be above the kidney in which case the appearance of a swelling will be long delayed it may be postero-inferior when it presents in the back and loin

Symptoms —In the secondary variety the symptoms merely complicate the previously existing disease

In the primary form the onset is usually misleadingly vague There is a history of recurrent boils during which time the patient is a little run down. Then there may be an interval after the last boil and later a distinct decline in the general condition with fever and great weariness Soon a swinging septic temperature is established with some pain in the back, often thought to be lumbago Occasionally the onset is abrupt with severe pain and a rigor The local signs may be absent or trivial and include some deep tenderness over the kidney pain and limitation of movement in the hip joint on the affected side. Later the loin will be filled up with a swelling that bulges in the back but does not spread forward to any extent It does not move on respiration, nor on palpation. In the suprarenal type there may be no palpable swelling Pus in the urine is a variable sign, but in the early stages staphylococci will almost always be present

Diagnosis may be unusually difficult The history and the general condition seem to point so obviously to a perinephric abscess and yet the long delay in the appearance of a swelling may be most misleading An X ray photograph may assist in obscure cases by showing a raised or immobile diaphragm on the affected side

Prognosis in primary cases is excellent but in secondary cases depends upon the original condition

Treatment —As this type of perinephric abscess is usually of staphylococcal origin penicillin therapy is instituted as soon as the diagnosis is made or possibly even only suspected Incision and drainage however are needed as soon as a palpable swelling is present If a pyonephrosis coexists it must be drained also and any causative lesion will need appropriate treatment It is wise to withhold operative interference until localising signs are evident Perinephritis without abscess formation should be treated with penicillin in these cases incision can do no good and may do harm.



Fig 371
Carbuncle of kidney

Carbuncle of the Kidney —Metastatic staphylococcal infection of the cortex does not always follow the sequence of events described under perinephric abscess Instead of a small subcapsular abscess a more chronic indurated swelling is formed this spreads slowly and shows little tendency to form pus In time a considerable area of the kidney is invaded by this chronic indurated lesion, to which the name carbuncle of the kidney has been applied (Fig 371)

The clinical picture is indistinguishable from that of perinephric abscess in its early stages before an external swelling has appeared, but a pyelogram may provide the diagnosis Many weeks of pyrexial illness are to be expected

These patients are treated in bed in the open air in a manner similar to cases of tuberculosis Penicillin and sulphadiazine may bring about a rapid improvement In resistant cases a nephrectomy may have to be considered if the kidney is extensively destroyed

CHRONIC INFECTIONS OF THE KIDNEY

Chronic Pyelitis

Chronic pyelitis once a common condition, is rapidly becoming an index of missed diagnosis or imperfect treatment and in time its very existence will be a reproach The introduction of the ketogenic diet was

accompanied by the return—in large numbers—of old patients with chronic pyelitis to see if at long last a cure had been found. Chronic pyelitis follows an unresolved acute attack and is characterised by the presence of pus and bacteria in the urine and slight symptoms of general loss of condition. These patients are liable to constant exacerbations of the infection and are suffering from a definite if slight diminution of renal function. Each attack takes away a little more of their reserves and their vitality The infection in such people is not limited to the renal pelvis but is a true pyelonephritis and all forms of treatment such as alkaline and acid diuretics vaccines and pelvic lavage are equally futile

Treatment—At the present time a patient with chronic pyelonephritis must be subjected to a complete urological overhaul The excretion from each kidney must be investigated for the presence of organisms for any abnormal constituent and for the efficiency of that kidney If the findings are compatible with the diagnosis of a simple urinary infection on one or both sides treatment by sulphadiazine is started forthwith If this fails to sterilise the urine it must be discontinued and in such patients streptomycin may achieve a lasting cure In long-standing cases, in which the infection is confined to one kidney the other being uninfected and efficient and if a pyelogram of the affected side shows appearances suggestive of renal damage then it will be wise to consider removal of the infected kidney

Syphilis of the Kidney

Bilateral subacute parenchymatous nephritis occurs in the secondary stage and is accompanied by a slight albuminuria and œdema of the feet It is usually transient but a few cases are on record of death from renal failure Tertiary syphilis gives rise to chronic interstitial nephritis and to gummata which latter are usually mistaken for neoplasms. These manifestations are uncommon

Bilharziosis of the Kidney

This is very rare the kidney being in a state of chronic nephritis and the pelvis inflamed and ulcerated Ova may be found in the pelvis in the kidney and in the subcapsular cysts

Actinomycosis

This is likewise very rare and in appearance differs in no way from its general characteristics elsewhere

Renal Fistula

The great majority of these fistulæ follow operations but three types are described Perirenal fistulæ unconnected with the urinary tract are due to perinephric abscess appendicitis, empyema or disease of the ribs or spine Spontaneous renal fistulæ are rare but may be seen in neglected cases of pyonephrosis in which the pus tracks towards the skin and finally bursts through Post-operative fistulæ imply either that the ureter is still obstructed that imperfect drainage has

been established or that the infection is tuberculous Appropriate treatment of the cause should suffice to cure the condition but nephrectomy may be required

RENAL TUBERCULOSIS

Renal tuberculosis occurs in an acute miliary form which is usually rapidly fatal and has no surgical interest and also as a chronic surgical infection. This type is never the primary focus in the body but is secondary to other lesions e.g in the lungs, the cervical or mediastinal lymph glands or the epididymis



FIG. 372

A left kidney with three distinct lesions illustrating the stages of tuberculous infection 1 the centre is a small early lesion which demonstrates the position where surgical tuberculous lesion starts At the upper pole a moderately advanced lesion is seen, and 3 the lower pole complete caseation has occurred.

Tuberculosis is one of the more frequent surgical lesions of the kidney occurring most commonly between the ages of 20 and 40 years and being very rare in infancy and old age The right side is slightly more frequently affected than the left and women than men. In its early stages it is rarely bilateral, but in untreated cases over 60 per cent of patients die with both kidneys infected

Pathology — The tubercle bacillus reaches the kidney in one of three ways either via the renal artery from a distant focus by the lymphatics around the ureter carrying the infection from the bladder or by direct extension from neighbouring structures e.g the ribs spine or bowel Three stages in the progress of the infection may be described —

1 **Pyramidal Origin.**—The earliest lesion is seen at the base of a pyramid and not at its apex as was previously taught (Fig 372) Spreading centrifugally it will destroy the pyramidal tissue and soon reach the mucous membrane of the calyx Erosion of the renal parenchyma *continues and is now* accompanied by spread along the calyx in the submucous layer By this means the infection passes into the neighbouring calyces and the pelvis

2 **Ulcero-cavernous Stage.**—Ulceration of the calyx and erosion of the renal parenchyma are proceeding simultaneously Each calyceal system tends to remain isolated from its neighbours by fibrous tissue, and there may be seen four to seven separate areas of caseation in varying stages of progress spreading slowly through the kidney cortex

3 **Tuberculous Pyonephrosis.**—Finally when each main centre has reached the capsule complete destruction of the kidney occurs and all that remains is a multilocular cavity containing caseous pus (Fig 373)

Involvement of the Ureter —The infection having reached the pelvis involvement of the ureter is certain The disease spreads in the submucous coat whence ulceration of the mucous membrane follows together with an infiltration and thickening of the whole ureteric wall This process starting at the ureteropelvic junction travels down the ureter and finally reaches the bladder in which the lesions first appear in the mucous membrane above and external to the orifice over the course of the intramural ureter

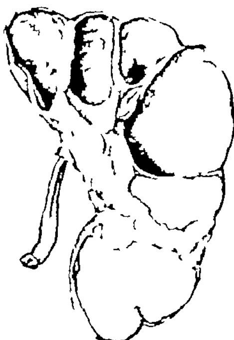


FIG. 373

A tuberculous pyonephrosis, the lower half of which retains the caseous material.

Spread from the Bladder —As soon as the bladder base is involved the infection is strategically placed to spread in several directions (see p 799) It may reach the lymphatics and begin to ascend the peri ureteric vessels and reach the opposite kidney it may travel into the prostatic urethra and thence in vade by lymph spread or direct involvement the prostate and vesicles finally it may ascend the vasal lymph vessels and reach one or both epididymes

Symptoms —Frequency of mic turition is the earliest symptom and is noticed during the day but as the disease progresses it will be present throughout the twenty four hours In the later stages it becomes most distressing urine being voided every quarter of an hour and finally the bladder becomes so contracted that incontinence is established Polyuria is a constant and an early symptom and can be shown to be localised to the affected side

The urine shows certain definite changes Pus will be found in timately mixed with the urine but on standing it will settle, leaving perfectly clear urine above it Moreover even on prolonged standing the urine remains clear which it fails to do in any other infection Tubercle bacilli will always be found if examined for by correct methods It is useless to rely upon the examination of a specimen containing but a few ounces of urine A full twenty four hours collection must be examined. This will not fail to show tubercle bacilli if the centri fuged deposit be examined with care Blood is a variable constituent in some patients a brisk hæmaturia is the initial symptom and in most cases red blood cells will be found in the deposit. Albumen may come from the affected kidney or from the other side due to a toxic nephritis Its presence alone is not a sign of tuberculosis but if unaccompanied by any other abnormal constituent it should lead to the examination of a twenty four hours specimen

Pain is conspicuous by its absence and even when present is frequently in the unaffected kidney as a result of compensatory hypertrophy



FIG 374

Ulcero-cavernous tuberculosis of upper pole of left kidney

Localisation of the Infection —In a patient whose urine contains tubercle bacilli two questions have to be answered first is the infection localised to one kidney? second, can the other kidney be proved free of infection and also efficient? Intravenous urography (Figs 374 and 375) will demonstrate the side of the lesion in over 95 per cent of patients and ureteric catheterisation of the opposite side will provide the answer to the second question. Cystoscopy will reveal the extent if any of bladder involvement and the specimen collected from the unaffected ureter will be tested for bacilli and for the percentage of urea If it is found impossible to arrange an intravenous urography the localisation must be done by cystoscopy alone Should the bladder be normal catheters are passed up both ureters and the urine of each examined for bacilli the negative specimen being estimated quantitatively for urea Tuberculous patients do not tolerate instrumentation well and all the information required must be obtained during one cystoscopy The changes which occur around the ureteric orifice are well defined and usually go through the following stages First there is hyperæmia with capillary congestion surrounding the orifice so that the typical appearance of the mucous membrane gives place to a dull red suffused zone with the orifice in the middle of it Later the thickening of the ureter converts



FIG. 375

An intravenous urography showing complete absence of secretion by the right kidney which can nevertheless easily be seen with mottled areas of calcification throughout it. This is the kidney shown in Fig. 373. The left kidney is seen to have a double pelvi and ureter

its opening into a round hole which projects into the bladder lumen and so stands out on an eminence As the congestion becomes more intense the efflux is sluggish and prolonged Later still along the line of the intramural ureter small tubercles form which develop into grey ulcers In the stage of healing the contraction of the ureter leads to the drawing up of the orifice in a funnel-shaped manner

Treatment—A tuberculous kidney must be removed provided no contraindications are present These are (1) the presence of tuberculous infection in the other kidney (2) active tuberculous lesions elsewhere *e.g* in the lungs joints peritoneum and other parts of the genito-urinary tract (the bladder excepted) (3) the absence or inefficiency of the other kidney and (4) serious general illness such as would preclude any operation The operation should include the removal of the ureter as far as the pelvic brim The *after-treatment* is as important as the operation After a course of streptomycin patients should be sent to convalesce in the open air but there is no need to insist upon the full rigour of sanatorium treatment In six months time they are examined for any evidence of urinary tuberculosis and as long as tubercle bacilli persist in the urine they must continue to live an open-air life No patient may return to an indoor occupation until three months have elapsed since the urine has been proved free from bacilli The treatment of those patients who are not suitable for nephrectomy should be a full institutional régime

RENAL CALCULI

General Considerations of Stone Formation in the Urinary Tract

The principles of stone formation are the same in every part of the urinary tract As yet there is no completely acceptable explanation of them Changes in the reaction of the urine though affecting the constitution of a stone have nothing to do with its initial formation The following facts are known —

1 Crystals must be present in the urine owing to supersaturation with one of its normal constituents but this alone is not sufficient for stone formation as they may be passed as such in large numbers (see Oxaluria p 770)

2 Certain colloids are present in normal urine but it is believed that an abnormal colloid of an irreversible type is needed to act as a cement substance to weld the crystals together into a stone nucleus

3 A nucleus having formed neither of these two factors need continue for such a nucleus will continue to grow if it remains in contact with constantly changing normal urine

4 Neither an adventitious nucleus nor an infection is necessary for stone formation in the urinary tract

5 Prolonged recumbency during treatment of such diseases as anterior poliomyelitis and

6 Alterations in calcium metabolism both favour stone formation

Reversal of reaction of the urine causes a difference in the constitution of the stone and mixed calculi can occur For example if a

TABLE SHOWING THE PHYSICAL CHARACTERISTICS OF URINARY CALCULI

	Reaction of Urine	Consistence	Colour	Outer Surface	Cut Surface	Crystals
	[illegible]	Hard	Brown or dirty yellow	Smooth and regular or smooth and lobulated.	Regular concentric laminæ.	Polymorphous.
	Acid	Soft and friable	White	Smooth and later dendritic.	Homogeneous.	Amorphous.
	Acid.	Very hard	Dirty grey	Mulberry or jagged crystals.	Wavy concentric laminæ.	( ) Octahedrons (envelopes). (b) Dumb-bells (short bar).
	Alkaline	Soft and friable	White	Smooth and dendritic	Homogeneous.	Calcium, stellar. Triple, knife rests and coffin lids.
Cystin	Acid	Neither hard nor friable	Honey t rning greenish blue.	Smooth and soapy	Homogeneous radiating fissures.	Flat hexagonal plates.
Xanthin	Acid.	Hard.	Red or cinnamon.	Smooth.	Homogeneous.	Whetstone.
Indigo	Acid.	Firm	Blue-black.	Polished.	Homogeneous.	
Cholesterin	Alkaline	Firm.	Honey coloured.	Smooth.	Homogeneous radiating fissures.	Rhomboids with an angle missing.

or in the pelvis gives rise to pain and hæmaturia both c which are made worse by exercise or jolting and are improve by rest The pain is both renal and referred The **Migratory Stor** attempts to leave the pelvis and enter the ureter It may succee in passing to the bladder at the first attempt it may progre some distance at the first effort but reach the bladder only aft several attacks of colic it may remain impacted in the uret and need removal or it may be held at the ureteropelvic junctic

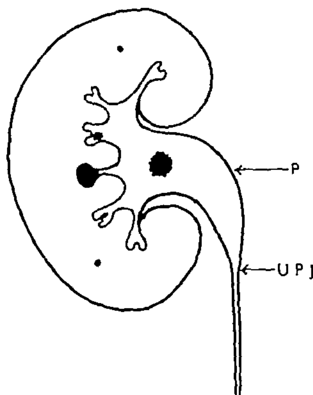


Fig 378

Diagram showing the various positions of stone in the kidneys.

P Pelvis; U-P.J Uretero-pelvic junction; Blue Silent stones; Red, Mobile stones; Green, Migratory stone

during the attack and then fall back free into the pelvis 7 migratory stone causes very severe attacks of renal colic which can controlled only by morphia. Vomiting at the time of onset is u and sometimes persists throughout the attack which will be termina by the release of the stone if it again becomes free in the pel Should it succeed in entering the ureter the colic continues and symptoms will be described later

Physical Signs —1 Examination of the patient will reveal lit Some deep tenderness in the loin or at the costolumbar angle r be elicited Heavy percussion over the renal area behind may prod

sharp stabs of pain but this test should not be employed A typical zone of renal hyperæsthesia is frequently found

2 Examination of the urine reveals abnormal constituents in between 70 and 80 per cent of cases in the form of albumen, pus blood, crystals or bacilli. A trace of blood and albumen is common, but pus comes only after a superadded infection. A non-catheter specimen, especially in women is valueless whereas a few pus cells or blood corpuscles found in a catheter specimen may be of great importance

3 X ray examination shows the great majority of stones Doubtful shadows can be identified by intravenous urography or ascending pyelography (Figs 370 and 380)



Fig. 379

X-ray showing dendritic calculus filling both pelvis and calyces.

Diagnosis—Any of the surgical diseases of the kidney may cause some difficulty but a complete urinary investigation leads to certain differentiation. The following non renal lesions may cause considerable doubt—cholecystitis gall stones peptic ulceration appendicitis and mesenteric adenitis—but renal and gastro intestinal radiography should solve the difficulty Subluxation of the sacro-iliac joints osteo-arthritis of the spine and the various types of cerebrospinal syphilis with tabetic crises should be considered in difficult cases

Treatment—(A) **Unilateral Calculi.**—The silent stone can safely be left alone and its rate of growth checked by X rays every six months In a sterile urine and in the absence of growth it may be left indefinitely

Stones in the calyces and pelvis should be removed The absence of infection is no reason for leaving them, but its presence makes operation essential Similarly those stones which give rise to colic by intermittent impaction at the ureteropelvic junction must be removed. The urgency lies in the fact that such stones damage the integrity of the kidney and on this account their removal should not be delayed

(*B*) **Bilateral Calculi.**—Cabot describes the treatment under four headings (*a*) large calculi in both kidneys (*b*) large calculus in one kidney small one in the other (*c*) moderate-sized calculi in both

kidneys (*d*) small calculi on both sides A patient with large calculi in both kidneys is in less danger than those in group (*b*) Large bilateral calculi imply that they have formed more or less silently over a long period. The kidneys are damaged but fairly well compensated and in the absence of infection there is some difficulty in coming to the right decision The age and general condition of the patient will decide the issue, the younger and sounder patient giving the best results If operation is considered, the kidney which shows the better renal function should be dealt with first.

In the case of a large calculus on one side and a small one on the other the latter should be removed at once so that any further damage to that kidney may be prevented and at a later date appropriate measures taken to deal with the other kidney In the last two groups the patient is unknowingly faced with the very serious complication of calculous anuria, and for this reason the stones should be removed as early as possible the more efficient kidney being dealt with first



FIG. 380

An ascending pyelography illustrating filling defect of the right renal pelvis caused by a non-radio-opaque calculus.

Pyelotomy is the operation of choice for all stones in the renal pelvis and for most in the calyces except in the presence of an advanced infection when a tube through the renal cortex is desirable for drainage Pyelotomy does no injury to the renal cortex and the incision can easily be sutured, healing readily without the danger of a urinary fistula After the removal of a stone a bougie must be passed down the ureter to prove that there is no obstruction. Nephrotomy should be confined to those cases in which either a branched stone is too large and irregular to extract through an opening in the pelvis or a stone is more or less shut off in one calyx In that it damages renal tissue this operation should be used only in especially difficult cases

Nephrectomy is reserved for those cases of calculous pyonephrosis in which the kidney is practically destroyed. It should not be performed unless the surgeon is certain that no hope of any recovery in the function of the kidney remains If there is any doubt a nephrotomy with drainage is the proper procedure

Complications —The following complications may be seen infection obstruction fibrosis and atrophy development of carcinoma and calculous anuria Infection follows stone in a large proportion of cases and leads to pyelitis pyelonephritis pyonephrosis and later possibly

to a perinephric abscess Obstruction leads to hydronephrosis (Fig 381) and if this becomes infected a pyonephrosis results. A carcinomatous ulcer of the renal pelvis is a rare occurrence Calculous anuria will be described at length as a complication of stone in the ureter (p 780)

Oxaluria

Crystals of all its constituents may be found in the urine but only those of calcium oxalate present a definite clinical condition known as oxaluria This is usually associated with a nervous dyspeptic temperament and the urine is found to contain a cloud of mucus with numbers of calcium oxalate crystals It is believed that most if not all of the calcium oxalate in the urine is derived from ingested food and certain articles of diet are known to have a high oxalate content Generally therefore this condition is of more interest to the physician than to the surgeon but occasionally it presents itself to the latter with an attack of colic caused by the sharp edges and angles of the crystals when present in very large numbers the colic is as severe as that due to calculus and blood will be found in the urine. Such a picture provides a difficulty in diagnosis and unless oxaluria is remembered as a possible cause of renal colic other more serious conditions may be suggested

CYSTS OF THE KIDNEY

The cystic conditions seen in the kidney are —

1 Congenital polycystic disease
2 Single cysts
3 Multiple cysts in chronic interstitial nephritis.
4 Cyst formation in new growths
5 Parasitic cysts

The multiple cysts in chronic nephritis are of no clinical interest Cyst formation in new growths is due to degeneration in a hypernephroma or is seen as an essential process in the teratoid tumours, and as such are merely incidental in the history of the tumour

Polycystic Disease

This is a condition in which both kidneys are slowly destroyed by the formation of cysts throughout the renal substance It is seen in two periods of life The infantile type appears very early sometimes being the cause of an obstructed labour or of a dead foetus, and in other cases resulting in death before 6 years of age The adult type rarely gives symptoms before 40 and is commonest between 45 and 55 years Women are more frequently affected than men and there is some evidence of an hereditary factor

Pathology —The condition is always bilateral but one kidney is often larger than the other The swelling retains the shape of the kidney even when it reaches a large size The surface is irregular with thin walled cysts projecting from it and the whole organ is



FIG. 381

Oxalate stone blocking the upper primary calyx. The lower half of the kidney remains normal, while the remainder is in a state of hydronephrosis.

riddled with spaces of varying size and colour between which the renal tissue is flattened atrophic and unrecognisable The pelvis itself and the connections between it and the calyces are elongated and narrow but the latter are normal in contour (Fig 382) The fluid in the cysts contains urinary constituents The condition may be associated with a similar change in the liver pancreas and spleen, and with other congenital anomalies such as cleft palate imperforate anus or club foot Microscopically the cysts are lined by flattened or cubical epithelium standing on a thin wall.

The origin of this condition is developmental. The kidney develops from two separate tissues The ureter pelvis and straight collecting tubules are derived from the ureteric bud of the Wolffian duct whereas the glomeruli and the convoluted tubules arise from the metanephric cap These two sets of tubules must unite before a functioning kidney is completed. Presumably in the infantile type there is widespread failure of union and in the adult group a sufficient number have joined to carry on the function of secretion until the kidney is later being subjected to toxic and metabolic disorders



FIG. 382
Congenital polycystic kidney

Symptoms —In the infantile group if the child is born alive it is an ailing weakly baby and dies of renal failure in its early months In the adult type the symptoms are certain indefinite changes in the output of urine the presence of a tumour hæmaturia and pain Many of these patients have a most vague history some discover a tumour in the loin quite by chance in others hæmaturia may be the initial symptom, whilst others notice that they have alternating periods of oliguria and polyuria The mass of the tumour may cause a dull dragging pain Sooner or later the second kidney becomes palpable In general patients remain well for a long time with little evidence of renal failure and the final picture of anuria is abrupt in onset and short in duration

Diagnosis in the stage when one kidney only is palpably enlarged is apt to be confusing especially if there has been hæmaturia but the appearances on pyelography (Fig 383) are so typical that a neoplasm can be excluded with confidence Prognosis is difficult and no prophecy as to time can be made with any safety These cases vary widely in the interval that elapses between the recognition of the tumour and death but the prognosis is more favourable when the tumour is first seen in later life Some patients will be found to have a raised blood pressure which must necessarily influence prognosis to a certain degree

Treatment—No surgical treatment is of any avail. If the kidney has been exposed under a mistaken diagnosis Rovsing's procedure may be adopted This consists in puncturing all the cysts visible but its results do not justify its adoption as a set operation General medical care should be directed to relieving the strain on the threatened renal function

Single Cysts

Such cysts may occupy as much as one quarter of the kidney They are also a developmental anomaly and will only rarely be seen clinically when they are present as a cystic swelling in the loin They will probably be mistaken for a hydronephrosis until a pyelogram has been taken Treatment is not necessary but if they are of large size or are giving pain they may be removed without fear of a fistula resulting

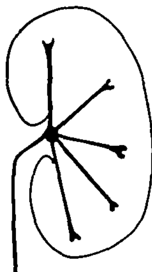


Fig 383

Outline drawing of pyelogram in polycystic kidney Not the small pelvis, long narrow tubular channels leading to normal calyces.

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Hydatid disease is seen in the kidney where it may produce no symptoms or signs save a tumour and a dragging pain in the loin until complications supervene Rupture may occur into the pelvis with the most severe colic hæmaturia and collapse The treatment is nephrectomy

GROWTHS OF THE KIDNEY

The classification of growths of the kidney is not so straightforward as in many other organs The following is believed to be as near pathological truth as possible

Primary Growths of the Kidney

	Epithelial	*Connective Tissue*	*Mixed*
Benign	Adenoma	Lipoma Fibroma Angioma	
Malignant	Hypernephroma Carcinoma	Sarcoma	Teratoblastoma

Secondary Growths of the Kidney

Carcinoma	Sarcoma

Growths of the Renal Pelvis

Benign	Papilloma	Angioma
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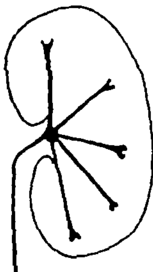


Fig. 280.

Outline drawing of pyelogram in polycystic kidney. Note the small pelvis, long narrow tubular channels leading to normal calyces.

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Carcinoma Sarcoma

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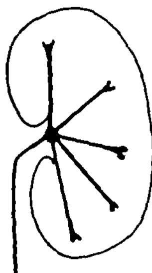


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Secondary Growths of the Kidney

Carcinoma	Sarcoma

Growths of the Renal Pelvis

Benign	Papilloma	Angioma
Malignant	Carcinoma	

Benign Growths are rare The adenoma is a pathological curiosity discovered usually at post-mortem examinations It is an encapsuled tumour beneath the renal capsule and as it is often seen in kidneys, which are affected with chronic interstitial nephritis it may be in the nature of a regeneration nodule The connective tissue growths are too rare and of too little significance to merit description

Malignant Growths

Malignant growths are not common constituting only between 0 5 and 2 per cent of the total cancer admissions to large hospitals The mixed tumours are most frequently seen in children under 6 years of age and the remainder in adults between the ages of 35 and 65 years, the maximum number occurring between 45 and 50 years Men are affected in the proportion of 3 2 and the two kidneys are equally attacked No predisposing factors are known and although calculi are sometimes coexistent there is little evidence to support them as an etiological factor



Fig. 384

A Grawitz tumour The apparent encapsulation of the growth is well seen; the upper pole appears quite normal, but the renal pelvis is full of growth.

Pathology—(*A*) Hypernephroma (Grawitz s Tumour) —This tumour may arise from any part of the renal cortex but usually springs from one or other pole and but rarely from the central area. Despite the size to which it may grow it tends to leave one pole surprisingly free *Its* external surface is smooth though lobulated, its colour varies from yellow to brown or red. In consistence it is firm except over areas of necrosis The cut surface is absolutely typical The tumour gives the appearance of firm encapsulation in places but elsewhere outlying nodules are present It is golden yellow in colour with areas of greyish necrosis and dark patches of hæmorrhage scattered throughout its substance There is an indefinite division into lobules by strands of bluish semitranslucent fibrous tissue The renal pelvis may be distorted or invaded (Fig 384)

Microscopically a frozen section stained with Sudan III and hæmatoxylin shows a brilliant red picture the tumour cells being laden with lipoid In paraffin sections the cells are large polygonal and vacuolated, with a pale scanty protoplasm and well-defined nucleus.

They are arranged in columns along the capillaries forming an alveolar type of tumour and in some cases there is a definite papillary grouping The appearances are strongly reminiscent of the zona fasciculata of the adrenal gland (*cf* Fig 43 p 110)

It spreads by embolism by direct permeation along the renal vein and by lymphatics to the juxta-aortic glands Vascular emboli lead to secondary deposits in the lungs In addition these growths show a *selective affinity for the bones* and many cases are recorded in which the bony deposit was the first sign of the disease Infiltration of the perirenal fat may also occur

Grawitz suggested that these tumours arose from misplaced adrenal cells which had been included in the developing kidney Such rests are known to occur and the tumour does bear a marked resemblance to the adrenal cortex Stoerk submitted that their papillary structure precluded their adrenal origin. Wilson and Willis believed they were of Wolffian derivation. The view held to-day is that they are primary growths of the kidney cells of a specialised type



FIG. 383

A kidney completely replaced by a teratoblastoma. Both artery and vein are shown full of growth.

(*B*) **Carcinomata** are indistinguishable from the sarcomata and the mixed tumours They are whitish grey homogeneous growths which spread rapidly through the kidney and grow to moderate size They vary greatly *in their microscopic* appearance some mimicking the renal tubules and forming an adenocarcinoma while others consist of a mass of undifferentiated cells—a carcinoma simplex

(*C*) **Sarcomata** are the rarest of all renal tumours Modern pathological diagnosis tends to place most of the so-called sarcomata among the teratoid tumours They are whitish grey growths which rapidly destroy the kidney and metastasise by the blood stream

(*D*) **Teratoblastomata** (Mixed Tumours of Infants Wilms Tumour) —These growths may arise anywhere in the cortex and not necessarily exclusively from the hilum as Bland Sutton suggested. They grow rapidly to a great size and destroy the kidney They are grey or ivory white homogeneous in appearance and have little tendency to hæmorrhage necrosis or cyst formation They spread by vascular embolism and by direct growth along the renal vein (Fig 383) Microscopically

they consist of tissue resembling a spindle-celled sarcoma and the other elements may not be easy to find but careful search will always reveal both striated and non striated muscle fibres and tall columnar epithelial cells arranged in tubules. Cartilage bone and the derivatives of the skin are very rarely found In the past a great many names have been applied to this tumour but the two given here are both pathologically correct and clinically descriptive whereas all others are misleading

Symptoms of all Renal Tumours are hæmaturia, the discovery of a tumour and mild dragging pain Hæmaturia is present in over 80 per cent of cases being most regularly found in the hypernephromata and least commonly in the teratoblastomata It is not of great severity at first but recurs in attacks of greater frequency and quantity It is often the only symptom and may appear in the form of worm like clots which are formed in the ureter A palpable tumour is likely to be of late occurrence particularly when the growth is in the upper pole In infants it may be the only sign and the tumour may attain great size Pain is not constant and is usually a dull ache in the loin, although referred pain may be present A sudden exacerbation is usually due to hæmorrhage occurring in the tumour Too much stress has been laid on the presence of a varicocele as a symptom of renal growth It is seen in a small percentage of cases and is of no significance except on the right side Here it may provide an additional piece of evidence but its absence means ...ing



FIG 398

A bilateral ascending pyelography showing distorted shadow on the left side due to Grawitz tumour

Diagnosis is made by intravenous urography which
a deformity in the shad ... more calyces If any ... is
an ascending pyelograph ... lly settle the questio ...
The prognosis is poor ... mixed tumour is ...
in adults carcinoma has ... mortality rate ... ie
hypernephromata is there ... e of a lasting o ...
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Growths of the Renal Pelvis

Papillomata are rare They are more frequent in men than in women and in the right kidney It is believed that workers in the aniline-dye industry are prone to them They are transitional celled tumours of the villous and pedunculated type The border line between the benign and malignant papillomata is ill-defined and apparently benign examples have been known to seed out in the ureter bladder or even in an operation wound They give rise to symptomless hæmaturia and to hydronephrosis if the tumour blocks the ureter Owing to their doubtful status these tumours must be treated by nephrectomy if the other kidney is efficient

An Angioma is occasionally seen in a calyx at the apex of a pyramid and may be the cause of essential renal hæmaturia (p 750)

A Carcinoma is either a malignant papilloma or a squamous-celled ulcer The latter is very rare and may be due to the irritation of a calculus It produces pain hæmaturia and possibly hydronephrosis and its treatment is nephrectomy

THE URETER

The ureter can be felt by abdominal palpation in thin patients and its termination is accessible to a finger in the rectum or vagina Its efflux may be studied by cystoscopy and its course defined in an X ray film by the passage of an opaque bougie In this way it can be seen crossing the tips of the 3rd 4th and 5th lumbar transverse processes passing just internal to the sacro-iliac joint and the ischial spine It then curves outwards and again inwards behind the shadow of the horizontal ramus of the pubis

Injuries

Subcutaneous Injuries are rare and give no immediate symptoms apart from a slight hæmaturia As the urine slowly leaks through a tumour forms which after several days will become infected If injury is suspected intravenous urography will provide the diagnosis and if it is a complication of an open wound the external leakage of urine will *quickly* reveal damage to the ureter Treatment consists in exposure and suture of the tear with drainage

Surgical Injuries.—The ureter *is liable* to injury in many surgical and gynæcological operations, *e.g.*, during the removal of carcinoma of the rectum or uterus ovarian cysts *cervical fibroids*, etc and it may be crushed during difficult forceps deliveries It *may* be divided cleanly lacerated or included in a ligature *or again its* blood supply may be cut off and sloughing of the wall occur later with fistula formation If recognised at the time suture over a ureteric catheter will give admirable results One of the commonest late sequelæ is the uretero-vaginal fistula, a source of the greatest discomfort and distress to the patient. These and similar lesions should be treated by the

implantation of the ureter into the bladder or failing this into the rectosigmoid junction Other fistulæ are known but are rare and they will heal spontaneously provided that there is no obstruction to the ureter

CYSTS OF THE URETER are rare They are seen in the intramural part and cause a prolapse of the ureteric orifice into the bladder The condition is either congenital (Fig 387) or due to inflammatory cicatrisation. The symptoms are those of hydronephrosis or renal infection and occasionally a calculus will form in the cyst

Treatment aims at the removal of any cause and slitting the orifice so as to leave a wide opening



FIG. 387

An intravenous urography showing on the right side a congenital ureterocele. On the left side a stone may be seen a similar cystic dilatation of the lower end of the ureter

URETERIC CALCULI

A primary ureteric stone forming around a ligature or other foreign body is extremely rare the vast majority reaching the ureter from the renal pelvis It might be imagined that the fact that a stone has entered the ureter would be a guarantee of its passing through to the bladder without difficulty but the ureter narrows at the pelvic brim and at its entrance to the bladder and at either of these points a stone may be arrested (Figs 362 and 387)

Symptoms are pain and some changes in the urine The pain varies in type and severity The contractions of the ureter give colic which is maximal at a point *over the position of the* stone There may be pain in the kidney area and referred pain in typical zones Some patients do not complain of severe colic but have persistent aching pain accompanied by a feeling of great tiredness When the stone reaches the intramural portion of the ureter frequency of micturition, strangury and penile irritation will be added to the picture The changes in the urine are those already described in the section on Renal Calculi (p 760)

The sequence of events in the passage of a ureteric stone depends upon its fate either it passes through to the bladder at the first attempt in which case the attack of colic terminates abruptly as soon as the stone falls free into the bladder or it is held up temporarily or permanently with intermittent attacks of colic The intervals vary between hours and many weeks and in the latter patients there is a danger of hydronephrosis

Diagnosis is made by X rays which will not only demonstrate the stone but will permit of its exact localisation by orientation with the transverse processes of the lumbar vertebræ and the various bony points of the pelvis and sacrum In this way the progress made after each attack can be verified Intravenous urography will demonstrate the early signs of hydronephrosis Cystoscopy will show pouting of the orifice and possibly also bullous œdema when the stone is in the intramural ureter

The differential diagnosis rests between renal and other forms of colic *i.e.*, biliary and intestinal. The type and distribution of the pain the urinary symptoms and the X ray pictures will solve any difficulty

Treatment—The patient will assuredly be seen during an attack of colic This is controlled by a hypodermic injection of morphia (¼ gr) and atropine ($\frac{1}{100}$ gr) the patient being put to bed and kept warm with hot water bottles If the stone is small and is going to pass in one attack, this treatment will suffice and it will be voided within a few hours.

Stones not Passing at the First Attempt.—The general principles are that (1) a stone making definite progress after each attack may be left to pass provided it is not taking too long and (2) every stone making no advance must be removed as soon as possible A patient with a stone impacted in the ureter is in danger not only of a slow deterioration of kidney function from back pressure but also of a sudden calculous anuria The management of these patients is clear after the first attack the stone is localised by radiography and after the second attack its progress is noted If the stone has not appeared after two months an intravenous urograph is taken, and if there is the least evidence of early hydronephrosis operation must be considered Many of the stones, however can be induced to pass by an injection of one of the acetylcholine group of drugs *e.g* trasentin

Palliative Treatment—During the attack the morphia and atropine injection is given and six hours later the following medicine administered by mouth and repeated every four hours until the pain has ceased —

Tinct opii	♏xv
Tinct bellad	♏vii
Tinct hyosc	ʒss
Syrupus aurantii	ʒss
Aquam	ad ℥i

During the intervals patients should be placed on a carefully regulated medical régime and at least 6 pints of bland fluids must be taken daily

Operative Measures—Cabot reports that of the stones which become impacted 15 per cent do so in the upper part of the ureter and 75 per cent in the pelvic portion The high ones are removed by the same approach as renal stones while those in the pelvis can be reached through either a midline or a lateral muscle-splitting incision with extraperitoneal dissection by the side of the bladder Those in the intramural ureter can sometimes be coaxed down by various means

such as passing two or three catheters up past the stone and inje sterile paraffin, when the stone may become engaged in the cath and *withdrawn with them. Stones firmly impacted in the o* should be removed by suprapubic cystotomy though the e: cystoscopist may feel justified in dividing the rim of the opening a diathermy electrode

CALCULOUS ANURIA

This condition the possibility of which adds a heavy burd anxiety to those in charge of a patient with a ureteric calculus co *in a sudden failure of secretion of urine It may be due tc* following combination of circumstances —

1 Simultaneous blocking of both ureters by stones
2 The blocking of one ureter the other kidney being absent e congenitally after operation or having been destroye disease
3 *The blocking of one ureter the other kidney being dis* either grossly or by the early stages of chronic inters nephritis

The occurrence of anuria will be more readily understood when *realised that during an attack of ureteric colic due to stone the fun* of that kidney is temporarily suppressed. This is proved by intrave urography during an attack when serial films show that no dye is l *secreted on the side of the calculus The opposite kidney therefo* abruptly subjected to an overload and, if diseased, may be unab respond

Symptoms are pain and the cessation of the secretion of u There may have been previous attacks of pain or the anuria ma ushered in with pain suggestive of a ureteric stone But it is c slight and indeed examples are on record when there has bee pain at all. The disease falls into two stages —

(*A*) **Stage of Tolerance.**—*From the start of the anuria the* a period lasting from six to twelve days in which the patient perfectly well. No urine or at most 1 or 2 oz in twenty four hc is passed. The absence of symptoms may mislead both the pat and the doctor neither of whom may appreciate the gravity of condition.

(*B*) **Stage of Toxæmia.**—The well being of the stage of toler ends abruptly and drowsiness headache and delirium appear N reflexes are absent or diminished, moven of the limbs are slug the pulse and o slow an ar and finally Che Stokes breathing dema is beent but abdom distension vomitu tion—d e ileus—and hicco are common De n he onset of this st

Diagnosis—Th no d diagnosis but difficulty lies in of t facts must

n call

on

2 The period of tolerance gives ample time for investigation if patients present themselves early enough and the number of days of anuria give an idea of the margin of safety left Under no circumstances whatever should treatment be left until the onset of toxic signs

3 An X ray will usually but not always define the position of the stone and in skilled hands the wax tipped ureteric bougie will give more sure information

4 Certain patients will present grave difficulties The pain may be non-existent or bilateral it may not be possible to localise the stone by any means or the patient may be seen for the first time at the beginning of the stage of toxæmia The procedure in these cases is fortunately clearly defined

Treatment—The obstruction must be removed without an hour's delay The stone or stones should be removed from one or both ureters In those difficult cases where localisation has failed both kidneys must be drained by lumbar nephrostomy This allows free drainage and the re-establishment of the secretion of urine and after the patient has come safely out of danger further steps can be taken to define and remove the stone

OPERATIONS UPON THE KIDNEY

Exposure of the Kidney is usually obtained from the side but in the case of very large tumours an anterior transperitoneal approach has certain advantages.

Oblique Lumbar Method.—The patient is placed upon his opposite side and the bridge raised so that the loin is opened up as far as possible The uppermost arm must be supported in a special tray to prevent pressure upon the chest An oblique incision is made midway between the 12th rib and iliac crest running parallel to the former It starts at the outer border of erector spinæ and proceeds forwards and downwards to the level of the anterior superior spine When properly placed this incision will be parallel to and half way between the 12th dorsal and 1st lumbar nerves. In those patients who have a very narrow interval between the last rib and iliac crest it is wise to remove the 12th rib this gives far better exposure The cut is deepened through the subcutaneous fat and each succeeding layer of muscle is divided, external oblique internal oblique and transversalis in that order Close to the edge of erector spinæ the transversalis fascia will be easily identified and it is wise to incise it early in the dissection so that a finger may be introduced to sweep away the retroperitoneal fat and the peritoneum itself from contact with the under surface of the transversalis fascia and muscle A sufficient exposure having thus been obtained the retroperitoneal fat is displaced forwards and the fascia of Zukerkandl identified in front of the lateral margin of quadratus lumborum. The beginner is apt to forget that this fascia is sufficiently strong and well defined as to need an incision with scissors or scalpel Until this has been done the perinephric fat cannot be displayed This fat is now stripped by gauze and finger dissection from every aspect of the kidney In normal patients this presents no difficulty but perinephritis will lead to adhesions which may offer considerable resistance to easy stripping The exposure of the kidney is now complete

Pyelotomy—Stones should always be removed from the pelvis and no incision made into the kidney unless absolutely necessary owing to the

size and shape of the calculus The kidney being exposed it is gently drawn into the wound and this is usually possible without undue tension. A retractor is inserted to control the posterior margin of the incision and the kidney held forwards thus enabling the surgeon to approach the pelvis from behind Gauze dissection clears the pelvis of its loosely adherent fat until it is fully visualised. Two stay stitches of No 0000 catgut are introduced and an incision made from the edge of the renal hilum downwards towards the ureteropelvic junction.

Stones are sought for by external palpation and by stone forceps within the pelvis they are grasped and extracted Care must be taken to remove every calculus present the number being checked from an X ray count and by careful palpation of the pelvis. A ureteric bougie should be passed down the ureter to demonstrate its patency and freedom from stones. The pelvic incision is then sutured with fine interrupted catgut stitches and a flap of perinephric fat brought across the suture line and stitched in position. A drainage tube is inserted into the perinephric space behind the kidney and the wound closed

Nephrotomy and Nephrolithotomy—Should it be essential for any reason to open the pelvis by cutting across the renal parenchyma, an incision is made in the so-called "bloodless line of Hyrtl" just behind the prominent lateral border and deepened until the pelvis is opened. During this and subsequent manoeuvres severe bleeding may be controlled by temporary compression of the renal artery A staghorn calculus having been removed or other pathology suitably dealt with the incision is closed This is not so easy as might appear since renal tissue is friable, yet we rely upon firm co-aptation to achieve hæmostasis Blunt curved needles are used to introduce deep mattress sutures of No 1 catgut. Finer needles and sutures bring the capsule together In many cases it will be necessary or at least wise to drain the pelvis by a small soft rubber tube brought out through the incision. The wound of the parietes is closed in the usual manner

Nephrectomy—The kidney having been exposed, it is brought up to the surface and its ureter defined and divided as low down as is required. Careful and gentle gauze dissection from both front and back defines the vessels Care must be taken to ensure that the pedicle is free of contact with the second part of the duodenum or the descending colon on the left before the clamps are applied. Cholecystectomy forceps are useful for this purpose a pair being applied and the vessels divided between them. All vessels are securely ligated and the wound closed with drainage

Closure of Wounds.—If the kidney has not been removed the rent in the fascia of Zuckerkandl should be repaired by three or four catgut stitches Each layer of muscles is then drawn together by mattress sutures and finally a continuous catgut stitch approximates the well marked fascia which covers the external oblique In most cases drainage tubes should be removed after forty-eight hours

Vertical Lumbar Method.—In an attempt to avoid the serious damage inflicted upon the lateral abdominal muscles by the oblique lumbar route Mayo suggests that the kidney may be approached by an incision along the lateral border of the erector spinæ The transversalis fascia is divided just lateral to the former muscle thus affording direct access to the kidney area without dividing muscle fibres. This incision, however is rarely used because the distance between the last rib and the iliac crest is so short that a most indifferent exposure is obtained and for this reason this method of approach is of academic interest only

OPERATIONS UPON THE URETER

Ureterolithotomy.—From its origin from the renal pelvis to its crossing of the iliac vessels, each ureter is approached from its own side exactly as described above with a probable extension of the incision forwards and downwards. The duct is freed from its fatty and peritoneal attachments and a small incision made in its long axis. The stone having been extracted it is rarely necessary to suture this ureteric incision which closes with little or no leakage of urine furthermore sutures might predispose to undue narrowing of the lumen.

The pelvic ureters are best approached by a midline subumbilical incision. The recti muscles being held aside the peritoneum is gently pushed upwards and the dissection carried round the lateral wall of the pelvis. The ureter is identified as it crosses the iliac vessels and traced downwards towards the bladder An incision is made in its long axis and the stone extracted. No sutures are required and the parietal wound is closed with drainage down to the ureteric incision

Plastic operations upon the ureteropelvic junction and methods of implanting ureters into bladder or colon will be found in textbooks of operative surgery

R. M. Handfield-Jones

THE ADRENAL GLANDS

The adrenal glands are situated immediately above the upper pole of each kidney being contained within a separate compartment of the fascia of Zuckerkandl. Each adrenal is a composite gland composed of two sections medulla and cortex The former is derived from the ectodermal precursor of the sympathetic nervous system, while the latter develops from the Wolffian ridge from which the gonads also arise

The medulla remains in close functional relationship with the sympathetic system and secretes adrenalin it is not essential to life because of the presence of similar chromaffin cells in other "glands such as the carotid body and in certain ganglia

The cortex seems to have many functions and from it certainly many chemical substances have been isolated. These are of a steroid nature related to cholesterol and the sex hormones. According to Vines four functions may be assigned to the adrenal cortex (1) a controlling action in the electrolytic balance in the blood and body fluids (2) control of certain aspects of metabolism (3) a powerful influence upon the normal function and development of the sex organs and (4) a mechanism for resisting certain toxæmias and shock following injury

ERRORS IN FUNCTION

Cortical Insufficiency may be acute or chronic Its acute manifestations may be abdominal with acute pain, vomiting and shock cerebral with coma or convulsions or asthenic with very rapid and continued wasting In all the prognosis is extremely grave

Addison's Disease is the chronic form of *cortical insufficiency* It is most commonly due (in over 60 per cent of patients) to bilateral destruction of the adrenal glands by tuberculosis Although the medulla is involved the clinical picture is governed by the damage to the cortex It is characterised

by affecting men rather than women by its insidious onset its leading to weariness, wasting and hypotension Pigmentation of the skin is a prominent symptom.

Although modern knowledge of cortical extracts has led to their successful use in many cases of cortical failure this is not so in Addison s disease The tuberculous lesion is persistently advancing and nothing can stop the inevitable fatal result

Cortical Hyperfunction is by no means always associated with definite neoplasms in the cortex in which hyperplasia may be found without any localised aggregations comparable with the adenoma of the thyroid gland *This hyperplasia may produce grave disturbances of sexual* development and characteristics

Briefly these can be grouped under two broad effects (*a*) masculinisation of the female and (*b*) feminisation of the male In the first type which is infinitely more common, there may be hermaphrodism sexual precocity adolescent virilism and climacteric virilism according to the age at which the hormonal dysfunction appears

In the latter type of which few cases are on record, a man will complain of loss of sexual desire and power development of breasts a change in the distribution of the body hair and atrophy of his testes The condition is closely associated with certain types of pituitary dysfunction *e g* Cushing s syndrome

ADRENAL TUMOURS

Primary tumours may be derived either from the cortex or medulla and classified as follows —

Cortical	Adenoma Carcinoma	Medullary	Chromaffinoma Ganglio-neuroma Neuroblastoma

Cortical Tumours

Adenoma.—A true adenoma is exceedingly rare and there is reason to believe that it tends to an early malignant change Pseudo-adenoma in cortical hyperplasia is not uncommon and is likely to be associated with one of the forms of hyperfunction already mentioned.

Carcinoma may be either an adenoma-carcinoma or carcinoma simplex. They occur in two separate age groups between birth and puberty or from 45 to 60 years. They metastasise by venous spread in a manner somewhat similar to hypernephroma of the kidney Some but not all are associated with sexual changes according to the age at which the tumour first appears. In the young sexual precocity will be seen *in later life there are hetero-sexual* changes

Medullary Tumours

Chromaffinoma, now known as Phaeochromocytoma is very rare occurring late in life and being probably benign. Clinically it is the cause of paroxysmal attacks of hypertension any one of which may prove fatal.

R M Handfield-Jones

CHAPTER XXXVI

THE BLADDER, PROSTATE AND VESICLES

ANATOMY.—The bladder when empty or moderately distended is entirely a pelvic organ but as the result of obstruction it may reach as high as or higher than the umbilicus. Its normal capacity is between 10 and 15 oz. The superior surface is concave when empty convex when distended, and is covered by peritoneum which separates it from the small intestine and the sigmoid colon As it distends it strips the peritoneum off the anterior abdominal wall and so becomes a contact relation with the abdominal muscles In front a space filled with fat and areolar tissue—the space of Retzius—separates it from the symphysis pubis. Its apex, directed upwards and forwards is attached by a fibrous cord, the urachus to the umbilicus. Behind in the male the seminal vesicles and the vasa deferentia lie between it and the rectum and below it rests on the prostate and the puboprostatic ligaments. In the female the anterior wall of the vagina and the uterus lie behind and below it. The neck of the bladder where it becomes continuous with the urethra is 2 in. behind the mid point of the symphysis pubis The trigone is a triangular area bounded by the interureteric bar above and lines joining the ureteric openings to the urethral orifice It is a distinct part of the bladder its muscle being derived from that of the ureters.

The bladder is supplied with blood by the superior and inferior vesical branches of the internal iliac artery and its venous drainage is into the internal iliac vein. The lymphatics pass to the glands on the external iliac vein and at the bifurcation of the aorta The nerve supply is from the 3rd, 4th and 5th sacral together with sympathetic twigs from the hypogastric and hæmorrhoidal plexuses

Examination.—An over-distended bladder forms a visibly prominent swelling having a central position in the lower abdomen It rises out of the pelvis as a spherical smooth tumour which is dull on percussion. The base can be palpated digitally from the rectum or vagina Cystoscopy allows a complete visual examination and after filling the bladder with sodium bromide an X ray picture will define its limits This is known as cystography

CONGENITAL ANOMALIES

PATENT URACHUS

This is a rare condition, and the degree of patency varies thus —

1 Complete i.e. a vesico-umbilical fistula.

2 Incomplete { Vesico-urachal sinus; Umbilico-urachal sinus; Intermediate viz. a urachal cyst.

The complete fistula is most commonly noticed because of the discomfort from leakage of urine at the umbilicus but it is probable

that a large number of bladders have some degree of symptomless vesico-urachal sinus either as a minute channel or a wide-mouthed diverticulum. The complete fistula is made obvious either at birth or in infancy by urinary leakage or may be seen in later life in men when prostatic or urethral obstruction forces open the persistent passage and urine appears at the umbilicus the patient not having previously been aware of the defect The umbilico-urachal sinus varies from a small tumour at the umbilicus to a minute sinus, which gets blocked and so gives rise to recurrent attacks of pain, tenderness and swelling The urachal cysts result from closure of the duct above and below with persistence in the middle. They form elongated rounded swellings in the midline between the umbilicus and pubis.

Treatment consists in removing any cause of obstruction, *e.g.*, phimosis in infants or enlarged prostate in adults when, if the fistula persists, the whole urachus should be removed Urachal remnants at the umbilicus should be removed owing to the possibility of recurrent infections while urachal cysts need removal for fear of malignant change No operation should be performed in infants until they reach the age of nine months or a year

Absence of the Bladder is a very rare condition and is accompanied by widespread abnormalities of the external genital organs The ureters open into some unusual structure *e.g* vagina, bowel or skin.

Ectopia Vesicæ

This is happily also a rare anomaly for it is difficult to picture anything more distressing It consists in a failure of development of the bladder save for a small basal area which includes the ureteric openings, and also in failure of growth of the skin of the anterior abdominal wall in the midline below the umbilicus There is a small area of posterior bladder wall therefore whose edges are firmly adherent to the margins of the skin defect The recti muscles are present but widely separated, and intra-abdominal pressure forces the bladder forward until it is flush with the surface The urine trickles away and spouts out on coughing or straining Associated with the bladder defect is a rudimentary penis in a state of epispadias (p 820) the urethra being represented by a groove The testes are retained in the abdomen, the pubic bones do not meet in the midline and the pelvis is generally malformed leading to a waddling gait Although there *is no developmental defect in the brain, untreated cases show a poor* mentality as they grow up and are backward in every way

Treatment—Attempts to reconstruct the bladder have always failed, and the only successful procedure is the transplantation of the ureters into the rectum or pelvic colon. Stiles operation is done in two stages the ureters being transplanted at different times six weeks being allowed to elapse between the two operations at the second of which the small amount of bladder wall is completely removed and the defect in the abdominal wall repaired In this chemotherapeutic age both ureters may be implanted at the same operation

DIVERTICULUM OF THE BLADDER

A diverticulum is a sac lined with vesical mucous membrane protruding from the bladder into the surrounding fat and opening into it by a narrow orifice It is more frequently recognised since diagnostic methods have improved and is not a rare condition.

Etiology—Diverticula may be single or multiple and vary in size from a peanut to a cavity larger than the normal bladder They are found on the lateral and posterior walls near the ureteric orifices or at the apex. They are very rare in women, but in males may be seen either in early childhood or in the later years after middle life when they follow those conditions causing urinary obstruction. The question of their origin remains hotly debated, some writers insisting that all are congenital and others that all are acquired. Similarly the presence or absence of muscle in their walls is disputed. There seems little doubt that they may be either congenital or acquired and many of them have muscle fibres irregularly arranged in their walls.



FIG. 388

Multiple diverticula of bladder revealed by cystography

Symptoms —They are symptomless until infection occurs. Stagnation of urine in them makes them prone to this and stone formation is likely but even so the symptoms are vague and varied. There may be unexplained attacks of frequency or of dysuria. Some patients complain that after a normal emptying of the bladder of clear urine they pass a copious amount of thick cloudy urine a few minutes later Some can produce the second emptying by pressure from above while others describe a feeling of the tumour moving downwards when the bladder is emptying It is safe to adopt the attitude in all atypical bladder cases that a diverticulum is a likely explanation.

Diagnosis—Cystoscopy and cystography will show the number size and position of the diverticula, but the photographs must be taken in several planes otherwise some shadows will be masked by that of the bladder itself (Fig 388)

Treatment—Owing to the impossibility of dealing adequately with the infection in a diverticulum and because of the danger of malignant change occurring in it its removal is advisable Appropriate treatment must be undertaken for the cause of any obstruction which may be present The diverticulum may be removed either from within the bladder or from without The ideal method combines the two avenues of approach. The bladder is opened suprapubically and the diverticulum packed with ribbon gauze to make it stand out firmly for subsequent recognition Extravesical dissection then readily isolates the diverticulum which is removed by division of its neck, the defect in the bladder being closed by sutures in layers. Drainage is maintained by an indwelling catheter for five days

ANOMALIES OF FUNCTION

The anomalies of function may be classified thus —

(Modified from Thomson Walker)

A Incontinence
- False
- True
  - Passive
  - Active

  due to
  - Mechanical causes
  - Nervous disease
  - Bladder spasm.
  - Nocturnal enuresis.

B Acute retention
- With obstruction.
- In spinal cord lesions
- In acute and chronic intoxications
- From inhibition or spasm
- From achalasia of sphincter

C Chronic retention from obstruction.

Incontinence of Urine

False *Incontinence or distension with overflow is a condition in* which the bladder is distended as a result of mechanical obstruction or of disease of the spinal cord when after the limit of its capacity is reached the urine simply dribbles away

True Incontinence implies an empty bladder In the *passive* type the internal sphincter is paralysed, and urine flows straight from the ureters to the urethra In *active* incontinence the sphincter is functioning but so inefficiently that the bladder contractions overcome it and the urine is expelled into the urethra.

Mechanical Incontinence is seen in women particularly after child birth, and in its mild forms is present only on straining coughing or sneezing Uterine prolapse with a cystocele is a common cause

Nervous Disease may cause either distension with overflow or true incontinence and symptomless anomalies of bladder function should always lead to an examination of the central nervous system and of the spine to exclude spina bifida occulta

Bladder Spasm may be so severe in acute and chronic cystitis and tuberculous disease that incontinence results

Nocturnal Enuresis of children may be simply a delay in the *establishment of voluntary control over the act of micturition* which in the first twelve months is automatic and some children learn control later than others In some cases children between the ages of 4 and 8 years who have had perfect control, develop the habit of wetting their beds Until recently the attitude of all concerned, parents, educational authorities and even the medical profession to such nocturnal enuresis was worthy of the Dark Ages the unfortunate children being treated as pariahs It is now understood that this condition can be cured in early years and no longer should it be necessary to exclude a child from boarding school because of this complaint

In the majority of children either a definite urogenital abnormality or an extrinsic lesion (intestinal worms rectal prolapse vulvo-vaginitis phimosis, cystitis or oxaluria) will be found. Any child having reached

the age of five years and not having gained full nocturnal continence must be subjected to complete investigation All extrinsic causes having been excluded a full urological investigation will be performed including (1) clinical examination of the external genitals of both sexes (2) chemical and bacteriological examination of catheter and twenty four hour specimens of urine (3) intravenous urography and (4) urethroscopy and cystoscopy Attention must be directed not only to the grosser defects such as phimosis imperfectly descended testis and hydronephrosis but to those rare congenital malformations folds and valvular flaps of mucous membrane in the urethra urethral strictures and narrowing at the bladder neck. Appropriate treatment of any defect that may be found will usually cure the condition

There will remain a number of children in whom the most searching investigation fails to reveal any abnormality They will usually be of a highly nervous disposition often an only child, spoilt and pampered not infrequently other psychological stigmata may be present *e.g.*, stammering Such children will generally be permanently cured by a full dilatation of the urethra by bougies Finally in about 0 1 per cent of cases the child will prove resistant to all forms of treatment Should this be so Millin s corpus spongiosum plication operation should be advised

Retention of Urine

A Acute.

1 Retention with obstruction is due to lesions in

- *A* The Penis—phimosis paraphimosis encircling rings or string and growths
- *B* The Urethra—stricture rupture stone acute urethritis and pressure from without
- *C* The Prostate—benign enlargement, carcinoma and acute prostatitis with or without abscess
- *D* The Neck of the Bladder—growth or an impacted stone

Diagnosis—It is essential to distinguish at once between retention and anuria and then to ascertain the cause of the retention. In anuria the bladder is empty or contains a small quantity of very concentrated urine in retention the tense dull suprapubic swelling is characteristic

Treatment—1 Retention due to Obstruction.—The patient is placed in a hot bath after a suppository of morphia and belladonna has been introduced into the rectum. If this fails a catheter must be passed and a note of warning is necessary It is dangerous to empty the bladder completely at the first catheterisation as death from renal hæmorrhage or anuria may occur Two methods of gradual emptying are in use In the first a catheter is tied into the bladder and a piece of rubber tubing is attached to it leading to a collecting bottle An adjustable tap is included in the circuit and the flow of urine so adjusted that the bladder is completely emptied within seventy two hours A second method entails the passage of a catheter every six hours On the first occasion it is removed when the bladder can no longer be palpated above the pubis and at the succeeding catheterisations more and more urine is evacuated till the bladder is empty in about

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seventy two hours Many patients will regain the power of voluntary micturition after one catheterisation

2 Retention due to Spasm or Inhibition occurs in hysteria and after rectal and vaginal operations and is treated by the application of large hot fomentations over the lower abdomen and the hypodermic injection of Doryl or Carbachol (in 0·001 grm. doses) These drugs are so powerful in their action that catheterisation is rarely necessary

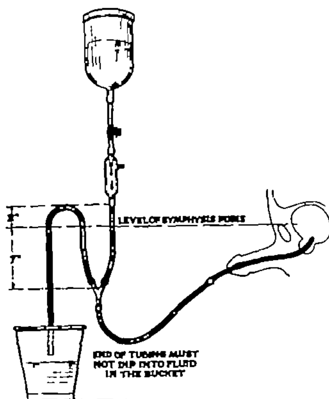


FIG. 389

Tidal drainage apparatus. (*Surgery of Modern Warfare.*)

3 Retention due to Spinal Cord Lesions—Those diseases and injuries which produce retention of urine raise a grave problem—that of the cord bladder No matter how carefully catheterisation is performed urinary infection is not only inevitable but usually fulminating There are two methods of treatment viz suprapubic cystostomy and tidal drainage Whichever is chosen it must be adopted at once and not after one or two days intermittent catheterisation. The former controls infection and prevents many deaths from renal failure the latter has two great advantages By rhythmically filling and emptying the bladder its muscles are kept in training for the day when automatic bladder control is taken over by the spinal centres Further the fluid used for irrigation is a mild antiseptic which assists in controlling infection. The apparatus is shown in Fig 389

4 Retention due to Achalasia of the Sphincter.—Retention either complete or with a bladder up to the umbilicus and a regular passage of about 4 oz of urine at frequent intervals is very occasionally due to imbalance of the two sides of the sympathetic system Although the detrusor muscle is able and willing to empty the bladder the sphincter refuses to give way Treatment is a pre sacral neurectomy

B **Chronic** retention is a condition in which there is a long standing partial obstruction without actual stoppage It is seen in all cases of enlarged prostate and urethral stricture The patho logical results are of the utmost importance In the order of their occurrence they are dilatation of the bladder hypertrophy of its muscle with trabeculation and sacculation dilatation of the ureters and the renal pelvis producing hydronephrosis Sooner or later infection super venes giving rise to cystitis ureteritis pyelitis and pyonephrosis The lesson to be learned is that benign enlargements of the prostate and urethral strictures are intrinsically of little importance but take on the gravest significance because of their far reaching and destructive effects on renal function.

INJURIES OF THE BLADDER

Contusions.—The mucous membrane may be bruised without an actual tear in the bladder wall The result depends on the severity of the bleeding and the presence of infection Slight cases present a transient hæmaturia which clears up rapidly while in others clot retention has been recorded, and in the presence of an infected urine severe sepsis may result

Rupture.—This is more common in men (9 1) and between the ages of 20 and 40 years It occurs when the bladder is full and often during alcoholic intoxication The cause is a kick, a blow or some crushing accident and a previously diseased bladder will always be more vulnerable Spontaneous rupture is seen in carcinoma of the bladder or ulcerative cystitis Fractures of the pelvis may lead to penetration of the bladder wall by fragments of bone The tear may be on the postero-superior surface when the peritoneal cavity will be opened or on the lateral and anterior aspects when the extravasation is extraperitoneal

Symptoms—**Intraperitoneal.**—There are two stages in the clinical picture the first or pre peritonitis stage lasting from twelve to twenty hours and that of peritonitis which becomes gradually established later Owing to shock and intoxication a reliable account of the accident or of the patient s condition is difficult to obtain.

First Stage—The injury is followed by severe shock and hypogastric pain with an intense desire to pass urine which results in only a few blood-stained drops Although no urine has been passed for hours no bladder dullness can be elicited but shifting dullness in the flank may be present If a catheter is passed a few drops of blood-stained urine will come away but if by gentle manipulation the catheter passes through the tear into the peritoneal cavity a large quantity of urine

Treatment—*A* **Acute Stage.**—Patients must be nursed in bed placed on a milk diet and given very large quantities of bland fluids as in the treatment of the acute febrile stage of pyelitis Massive linseed poultices over the lower abdomen will to some extent relieve the pain, frequency and strangury or patients may be lifted into really hot hip baths. Sleep is essential, and morphia and atropine will be needed at first. In severe cases where sleep is impossible and the general condition is deteriorating rapidly a suprapubic cystotomy should be performed. During the acute stage no attempt at cystoscopy or lavage is justifiable Many patients will improve rapidly on sulphadiazine or penicillin should the organism be susceptible

B **Post-febrile Stage.**—Investigations are now directed towards the causative or predisposing factor which must receive appropriate treatment The cystitis and bacilluria should be treated with sulphadiazine which will effect a permanent cure in most cases. Intractable cases will require bladder lavage with silver nitrate (1 6 000) or mercury oxycyanide (1 5 000) most usefully given by means of tidal drainage Patients must remain in bed for ten days after the temperature has become normal

Chronic Cystitis

The changes in chronic cystitis are very varied but essentially the inflammation spreads into the muscle coats with the result that the bladder is no longer capable of normal distension, and in advanced cases can hold only 1 or 2 oz of urine The mucous membrane shows a variety of appearances *Granular cystitis* denotes a thickened and plicated mucous membrane *vegetative cystitis* a more advanced condition, and *cystitis cystica* the proliferation of the epithelium into small cyst-like areas *Pseudomembranous cystitis* is a variety in which sloughs are formed and slowly shed and *gangrenous cystitis* a more advanced stage with widespread necrosis of the bladder wall In the early stages the muscle is hypertrophied but still capable of re-education to normal extensibility later fibrosis occurs making diminished capacity permanent.

Symptoms are those of acute cystitis in a mild degree frequency being pronounced and periodic exacerbations common. In the slight cases they may be hardly noticeable The urine will contain pus or mucopus epithelial debris and organisms

Treatment —Any coexisting disease must be treated, as it is otherwise useless to attempt to cure the cystitis. Bladder washouts are of great service and continuous irrigation through a two-way catheter the most efficient method The bladder must be gradually distended to normal capacity by daily clamping of the catheter The urine will become sterile with sulphadiazine. Cystitis due to *B proteus* will not yield to chemotherapy but responds to silver nitrate irrigations most usefully given by means of tidal drainage

Tuberculous Cystitis

Tuberculosis of the bladder is invariably secondary to infection in other parts of the genito-urinary system Primary cases are reported

but the evidence is not conclusive It is more common in men between 20 and 40 years of age

Method of Infection—When secondary to a renal infection the disease spreads into the bladder wall from the intramural ureter and so reaches the bladder just above and external to its orifice Tuberculosis of the male genital tract reaches the bladder either from the prostatic urethra or from the seminal vesicles

Morbid Anatomy and Cystoscopic Appearance have been described under renal tuberculosis (p 707) In protracted cases the bladder wall becomes hypertrophied and contracted and in the presence of a mixed infection undergoes the changes typical of chronic cystitis

Symptoms are those of chronic cystitis viz frequency and pain, and the urine contains pus blood and tubercle bacilli.

Treatment—If possible the primary cause must be eliminated and it is well recognised that the vesical lesions respond favourably to treatment after nephrectomy and to a lesser extent after orchidectomy General constitutional treatment in a suitable climate with injections of tuberculin and streptomycin will hasten progress Urinary antiseptics are of no value except in mixed infections and local treatment to the bladder is to be avoided

Bilharzial cystitis has been described in Chap IV p 52

FISTULA

Suprapubic Vesical Fistula.—After a suprapubic drainage of the bladder a fistula may persist usually in the lower part of the wound Failure of closure may be due to an unrelieved urethral obstruction severe sepsis tuberculous or carcinomatous invasion of the track adherence of the bladder to the wound edge prolapse of an atonic bladder wall or rarely to trophic changes connected with disease of the central nervous system The fistula may partially heal and then recur and it may transmit all the urine or only part of it

The *treatment* is the removal of the cause except in those cases in which a permanent fistula has been made as a method of treatment for inoperable urethral obstruction.

Vesico-intestinal Fistula.—This may be traumatic or pathological. The latter is due either to inflammation or new growth of the bladder or neighbouring parts of the intestine Examples of inflammatory fistula are those due to chronic cystitis with pericystitis appendicitis with abscess formation pelvic peritonitis tuberculosis of the cæcum or diverticulitis of the colon whilst the malignant fistulæ are due to growths of the bladder colon or cæcum

The symptoms are those of a slowly progressive chronic cystitis which when the fistula is complete become more marked bubbles of gas being passed with the urine

Treatment—Some inflammatory fistulæ heal spontaneously but in others a colostomy must be performed to remove as far as possible the source of infection and radical excision of the diseased areas must be considered. (*Vide* Diverticulitis of the Colon)

Vesico-vaginal Fistula.—This type rarely exists except as a result of surgical interference or of the injuries of childbirth The fistula

opens high up on the anterior wall of the vagina The symptoms are distressing both mentally and from the excoriation of the skin of the vulva and thighs. The fistula must be closed after careful preliminary preparation to clear up the infection of vagina and bladder The bladder and vagina are separated by a combined suprapubic and vaginal approach and each is carefully repaired An indwelling catheter is left *in situ* for ten days.

VESICAL CALCULI

Etiology —Our present knowledge of the etiology of urinary calculi has already been dealt with (p 769) It remains to add certain points concerning the bladder Generally conditions are more favourable to alkaline decomposition so that phosphatic stones are apt to predominate especially during the later years of life in men, when obstruction is common. In children vesical calculi are more frequently seen than renal. The number may vary from one to as many as four hundred and when multiple they are faceted. A single stone is spherical unless forming in a diverticulum, when it will be dumb-bell in shape. Spontaneous fracture occurs occasionally

Symptoms— *A* **Silent Stones.**—Stones may form without symptoms, and will always do so if they are prevented from coming into contact with the trigone Such conditions are present when a stone grows in a diverticulum or in a retroprostatic pouch

B **Stones Irritating the Trigone.**—There is no characteristic picture produced exclusively by a vesical calculus Any pathological condition causing irritation of the base of the bladder gives a typical syndrome The symptoms are —

(*a*) Pain is absent in a full bladder with the patient at rest, but is felt on movement and particularly on emptying the bladder At the end of micturition the contracting bladder presses the stone against the trigone and the pain is greatly increased. Referred pain will be felt along the urethra, at the tip of the penis rarely in the testes and occasionally in the back, foot or heel Children may be brought for advice as to a prolapsed rectum the result of straining caused by bladder irritability

(*b*) Sudden stoppage of flow during micturition used to be regarded as one of the cardinal symptoms, but is not always present and may be found in other conditions

(*c*) Frequency is usually a symptom.

(*d*) Abnormal constituents vary from a few red blood cells with an occasional shed epithelial cell to a foul stinking urine loaded with pus

(*e*) Priapism more common in the young, which may lead to masturbation

Diagnosis —This is certain as stones can so readily be seen through a cystoscope but it is necessary to ensure that no coexisting lesion is overlooked For this reason though an X-ray

photograph will show the stone (Fig 301) a cystoscopic examination is essential before treatment can be planned.

Treatment —The solution of a vesical calculus by drugs administered orally remains entirely mythical. Coexisting lesions may require medical treatment but the stone itself must be removed either by litholapaxy or by suprapubic lithotomy

Litholapaxy is the operation of crushing the stone into small fragments by an instrument named a lithotrite after which the pieces are removed by a Bigelow's evacuator In this way no incision is made and the patient needs only twenty four to forty-eight hours to recover from the anæsthetic and can return to full activity at once There are certain definite contraindications to crushing viz —

1 Too small a urethra
2 A severe cystitis
3 The presence of coexisting conditions the treatment of which demands a suprapubic approach
4 Stones in unduly large numbers
5 Stones larger than 2 in. in diameter No stone is too hard
6 Lack of skill in the operator



FIG. 301

X ray photograph of stone in the bladder later successfully treated by litholapaxy

Lithotomy is the removal of the stone by opening the bladder This requires a suprapubic approach which is easy to perform and certain in result but means at least fourteen days and often longer in bed, with resultant weakening of the patient's general condition.

The contraindications to litholapaxy must be strictly observed, but any patient with a stone suitable for crushing should never be submitted to a suprapubic operation There can be no conceivable justification for a surgeon performing the latter simply because he does not possess the requisite skill to undertake litholapaxy It is not to be forgotten that the best interests of the patient alone decide the issue

FOREIGN BODIES IN THE BLADDER

Foreign bodies may reach the bladder either by introduction along the urethra, gunshot wounds injuries or operations The first group is by far the commonest and many curious articles have been introduced into the bladder particularly in the female e g., hairpins safety pins small toys beads straws and catheters either whole or in part In view of an intelligible reluctance it is often some time before

such patients ask advice The symptoms are then those of mild cystitis with calculus The true nature is revealed by radiography and cystoscopy Many foreign bodies can safely be removed by an operating cystoscope others will require a suprapubic cystotomy

GROWTHS OF THE BLADDER

These can be classified as follows —

	Epithelial	*Connective Tissue*
Benign	Adenoma Papilloma.	Fibroma. Fibro-angioma Myoma. Angioma.
Malignant	Carcinoma	Sarcoma.



Fig 392
Papilloma of the bladder

The benign growths are all rare except the papilloma an adenoma may be seen at the base of the bladder arising from the glandular elements in the deepest layers of the mucosa. A fibroma occurs as a submucous tumour projecting into the bladder cavity a rhabdomyoma is occasionally seen in children, and an angioma may give rise to vesical bleeding

Papillomata

These are the commonest bladder tumours and over 50 per cent are found close to the ureteric orifices They are more frequent in men (3 1) and 74 per cent occur between 30 and 60 years they may be either single or multiple and are said to have a high incidence in aniline dye workers.

Pathology—Their appearance varies widely and it is impossible to distinguish with certainty the benign from the malignant Two groups are described. The villous type consists of delicate filaments of varying length with a fine connective tissue core arising from a circumscribed base with a short broad pedicle The processes can only be appreciated when floating in fluid, as on removal they collapse and the tumour appears as a soft spongy mass. They are frequently multiple and are capable of seeding out in the bladder wall and in an operation wound. The second type is coarser with short club-like processes and is rarely multiple The pedicle may vary in length and thickness (Fig 392)

The processes consist of a loose vascular core and a covering of transitional epithelium (Fig 393) They are a precancerous condition

and the microscope alone can reveal their true nature Invasion of the bladder muscle is not essential to malignancy for in the periphery at the apex of a process cells may be found erupting through the basement membrane

Symptoms —A symptomless, spasmodic and often severe hæmaturia is seen The attacks are transient, rarely lasting over five days and the free intervals may be months The hæmorrhage is profuse in most cases but in others trivial No satisfactory explanation is forthcoming for this periodicity There may be



Fig 303
Microscopic drawing of a papilloma of the bladder

slight pain on micturition and obstruction to the ureteric and urethral orifices producing symptoms of hydronephrosis or difficulty of micturition

Diagnosis and Prognosis —Cystoscopy will reveal the lesion So difficult is the differentiation between benign and early malignant papillomata that only an expert cystoscopist can hope to attain a high percentage of correct diagnoses. Destruction of a benign papilloma leads to a lasting cure but their multiplicity ability to seed out and precancerous proclivities make prognosis a difficult matter and a guarded opinion is always wise

Treatment—A Endovesical.—These tumours are easily destroyed by "fulguration with the diathermy current applied through a catheterising cystoscope No anæsthetic is necessary Every benign

papilloma is suitable for this method, size and multiplicity being no contraindication, the tolerance of the patient alone dictating the length of each application.

B **Suprapubic Removal** is sometimes advised for very large or for multiple tumours If a diathermy instrument is available the endovesical method is to be preferred, unless the patient is unable to tolerate repeated treatments

CARCINOMA

This is rare before 40 most frequent between 50 and 70 years of age and commoner in men The majority are malignant papillomata

Pathology—1 **Papillary Carcinoma** or malignant papilloma starts as a benign growth, and infiltration of the stroma of the processes, pedicle or base occurs The processes become thickened and tend to fuse an indurated area surrounds the base and the mucous membrane becomes fixed to the underlying muscle Ulceration phosphatic incrustation and necrosis may occur on the surface

2 **Scirrhus Carcinoma** is occasionally seen as a hard nodular mass with a broad base The mucosa may be fissured and ulcerated, but this growth spreads in the submucous layer and the mucosa is often little affected.

3 **Malignant Ulcer** is very rare and has the typical appearance of a *squamous*-celled carcinoma.

4 **Adenocarcinoma** is even rarer occurs at the base and tends to spread outside the bladder

The malignant papilloma retains its papillary character while it is still in the processes or pedicle, but on infiltrating the bladder wall it assumes a carcinoma simplex form The scirrhus growth is a carcinoma simplex with a large amount of fibrous tissue The ulcer is a squamous-celled growth, and the adenocarcinoma shows gland spaces lined by cubical or columnar cells

All types of papilloma seed out locally The malignant tumours are slow to spread outside the bladder wall and to metastasise at a distance The growth so often obstructs the ureteric orifices that death from renal failure is more common than from general spread.

Symptoms—In the malignant papilloma, the hæmaturia becomes less periodic and finally is persistent in varying amounts Frequently it is so slight that a patient is unaware of any urinary trouble until ulceration occurs as it must inevitably sooner or later The picture is then that of cystitis with pain frequency and an extremely offensive urine The scirrhus growth will be symptomless for a time and then there occur pain frequency and bleeding The ulcerating growth gives pain and symptoms of chronic cystitis Adenocarcinoma remains silent until bladder ulceration or extravesical spread has occurred

Treatment—*A* **Radical**.—Small growths may be successfully removed by partial cystectomy one ureter being divided and reimplanted if necessary Larger tumours—still confined to the bladder—are increasingly being dealt with by total cystectomy preceded by a preliminary course of X rays. As our experience of this operation increases, its results are steadily improving

B **Palliative.**—Pain hæmaturia and frequency may become very distressing For a time great improvement will follow intensive deep X ray therapy Later transplantation of the ureters into the colon is justifiable and at the same time a pre-sacral neurectomy will allay the pain

SARCOMA is a rare tumour occurring either in the young or in later life In the young grape-like masses project into the bladder cavity while in the older type the tumour resembles a scirrhus plaque

OPERATIONS UPON THE BLADDER

Suprapubic Puncture.—A distended bladder consequent upon acute retention can easily be emptied by means of a trocar and cannula A wheal in the skin 1 in. above the symphysis pubis having been raised with 1 per cent. novocain, a small puncture is made with a sharp-pointed tenotome Through this the trocar and cannula are thrust backwards and downwards on removing the trocar urine will flow freely through the cannula. This procedure is simple and easy but it should be regarded purely as an emergency measure when no other method can be made available at short notice moreover appropriate treatment must be directed to the cause within twenty four hours It should never be practised in the presence of infection.

Suprapubic Cystostomy—The bladder may be approached either through a midline incision above the symphysis pubis or by a curved cut concave upwards the central point of which is 2 in. above the symphysis. The anterior rectus sheath is opened and the muscles separated and held aside Subperitoneal fat now comes into view and must be gently swept upwards with the gauze-covered finger This displays the reflexion of peritoneum from bladder to anterior abdominal wall. Below it will be seen the bladder easily recognisable by its brownish colour coarse muscle bundles and large veins upon its surface It is important that it should be opened high up just below the peritoneal reflexion Two stay sutures are introduced ½ in apart and the bladder wall incised sufficiently to admit the surgeon s index finger The condition within is palpated, recognised and suitably dealt with (the last requiring an extension of the incision) Finally the bladder is closed around a rubber catheter of the flanged or self-retaining type placed at the upper margin of the incision. Bladder sutures should invariably be of catgut.

Partial and Total Cystectomy and Implantation of Ureters will be found described in textbooks of Operative Surgery

THE PROSTATE AND VESICLES

Anatomy—The prostate is chestnut-shaped and measures 1½ in by 1¼ in. by ¾ in. in its transverse vertical and anteroposterior diameters The base is concave and surrounds the neck of the bladder being pierced by the urethra and the ejaculatory ducts The convex anterior surface is separated from the symphysis pubis by a pad of fat and the puboprostatic ligaments. The apex rests on the triangular ligament and the posterior surface is flat and applied to the anterior surface of the rectum. The rounded lateral surfaces are surrounded by the anterior fibres of the levatores ani. It is enclosed in a fibrous capsule and around its lateral and anterior surfaces is a plexus of veins (the prostatic plexus of Santorini) while outside this is a reflection of the rectovesical layer of the pelvic fascia.

The gland is described as having a middle and two lateral lobes, the former lying behind the urethra between the ejaculatory ducts and the base of the bladder The urethra is crescentic on section, the concavity being filled by the verumontanum which projects from the posterior wall of the urethra. On its surface is the opening of the utricle in the midline, on either side of which are the orifices of the ejaculatory ducts. The prostatic ducts open into the sinus on either side of the ridge.

The prostate is supplied by branches of the inferior vesical and middle hæmorrhoidal arteries the venous plexus drains into the vesical veins and so into the internal iliac veins. The lymphatics pass to the iliac and sacral glands.

Anatomy of the Seminal Vesicles—The vesicles are a pair of glandular reservoirs lying behind the bladder between it and the rectum and above the prostate. On surface view they have a corrugated appearance similar to a bunch of varicose veins. They converge towards the middle line, where their ducts join the vasa deferentia to form the ejaculatory ducts. The lumen is a convoluted channel with many small diverticula The blood supply is from the middle hæmorrhoidal and inferior vesical arteries and the lymphatics drain into the iliac glands.

Method of Examination —*A* Rectal. With the patient in the knee-elbow position, the posterior surface can be explored by a finger in the rectum The lateral lobes are separated by a shallow vertical groove and on either side the finger may be pushed forward to examine the lateral surfaces Above the prostate a transverse groove separates it from the seminal vesicles. The finger can define the extent of any enlargement, the persistence or obliteration of the vertical and transverse grooves and alterations in consistency and sensation. Changes in the vesicles can be recognised as they are just within reach

B Cystoscopy will reveal any intravesical enlargement and the presence of other pathological conditions in the bladder It will assist in the differentiation of benign and malignant enlargements.

Prostatitis.—Acute prostatitis occurs chiefly in connection with gonorrhœa it is also a well recognised manifestation of staphylococcal septicæmia It is rarely found in other conditions The symptoms and treatment are described elsewhere (p 58)



Fig. 391
Prostatic calculi.

Chronic prostatitis is a very common residual complication of gonorrhœa and is described under that heading

Tuberculous prostatitis is dealt with under genital tuberculosis (p 838)

Prostatic Calculi.—Prostatic calculi are by no means uncommon They are said to arise by deposition of oxalate and carbonate of lime in the corpora amylacea and are always small and multiple Many give no symptoms others give perineal pain and disturbances of micturition while a few ulcerate into the urethra and

thereby produce agonising pain especially upon micturition Diagnosis can often be made by rectal palpation and confirmed by radiography (Fig 394) They are best removed by a perineal exposure without opening the urethra

SENILE ENLARGEMENT OF THE PROSTATE

Prostatic enlargement occurs after the age of 55 years, and is one of the most common surgical diseases of men in later life There are some grounds to believe that an endocrine imbalance is responsible for it



FIG. 395

The microscopic ppearance of senile hypertrophy of the prostate.

Pathology—The enlargement may affect the lateral lobes and remain entirely below the bladder it may affect the middle lobe and produce an endovesical tumour or more commonly both types of enlargement coexist The change may be localised to one lateral lobe but the anterior part of the gland in front of the urethra rarely suffers to any extent.

The enlargement of the middle lobe follows the path of least resistance viz., upwards beneath the base of the bladder The part affected is the small area behind the urethra and between the ejaculatory ducts The growth pushes upwards beneath the vesical mucous membrane displaces the internal sphincter outwards and projects into the bladder An endovesical tumour is then formed in the trigone covered with mucous membrane and behind it lies the postprostatic pouch, in the floor of which the ureters open The bladder shows hypertrophy trabeculation and possibly sacculation.

The microscopic appearances are those of irregularly shaped alveoli lined by columnar or cubical epithelium, standing on a deeper single layer of flattened cells with well marked nuclei. The acini may contain typical corpora amylaceæ (Fig 395) Although single small encapsuled adenomata occur the great majority of these senile enlargements are in the nature of a diffuse hypertrophy in which all the elements of the prostate gland take part.

Its Effects on the Genito-urinary System—(1) The urethra is increased in length particularly along its posterior wall, and its crescentic shape on cross-section is converted into an anteroposterior

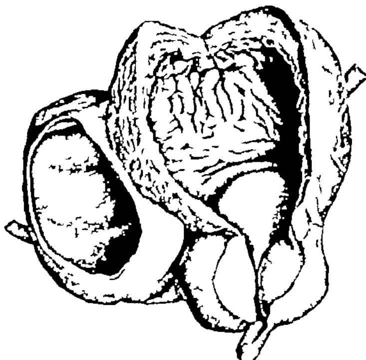


FIG. 396

A bladder opened from the front to show the effects of obstruction by an enlarged prostate. The hypertrophy and trabeculation of the bladder wall are well shown. An unusually large diverticulum is present.

slit This increase in length has an important clinical bearing in that an ordinary rubber catheter may fail to enter the bladder although encountering no difficulty A coudé or bi-coudé catheter will therefore be used (2) The bladder shows an endovesical growth a postprostatic pouch and all the signs of obstruction (3) The ureters are dilated and the kidneys are in a condition of hydronephrosis (4) Pressure on the ejaculatory ducts may obstruct them completely or partially (5) Compression of the venous plexus leads to engorgement of the veins in the bladder and in some cases a condition of varicosity appears in the middle lobe and may be a source of severe bleeding (6) Infection may be long delayed but eventually cystitis ureteritis pyelitis and pyelonephritis occur with a failing renal function (Fig 396)

Symptoms—An enlarged prostate is of *no intrinsic* importance its great significance being based on the severe damage it may do to renal efficiency The early symptoms are frequency and difficulty of micturition

1 Frequency is first noticed at night The early hours of deep sleep are undisturbed but afterwards the patient is awakened two or three times before rising As time progresses the nocturnal frequency becomes more severe and the day is also affected. It is not due to cystitis as was previously taught for many patients have an enlarged prostate for years without infection whereas frequency is always the first symptom. It is due to a disturbance of the neuromuscular control brought about by changes at the bladder base

2 Difficulty is in every stage of the act A minute or more may elapse before the stream starts and straining makes it more difficult When started, the stream has fair volume but little power and there is a little dribbling at the finish.

Other symptoms may be hæmaturia, acute retention and sexual excitation.

3 Hæmaturia may be present and is not necessarily an indication of malignancy In rare cases severe hæmorrhage occurs in the bladder which fills with clot leading to retention. The source of the bleeding is a ruptured vein on the middle lobe

4 Acute Retention must be the fate of almost all untreated cases and is the symptom which brings many patients to seek advice Sudden retention is brought about by acute congestion of the mucous membrane at the bladder neck and is precipitated by excesses of food, alcohol, sexual excitement or severe chills

5 Sexual Excitation.—There are grounds to believe that prostatic enlargements may lead to increased sexual excitation and account for some cases of sexual perversions The condition may thus assume medico-legal importance

Diagnosis—Every man over 55 years of age complaining of frequency and difficulty of micturition will be suspected of having an enlarged prostate A rectal examination reveals the enlarged lateral lobes the cystoscope shows a middle lobe in the bladder and establishes the presence or absence of any other condition. The amount of *residual* urine will be tested. This is the amount withdrawn by catheter from the bladder immediately after voluntary micturition

Prognosis—As far as the prognosis is affected by the urinary tract condition this can be adequately estimated by renal efficiency tests. Other coexisting lesions will need to be appraised at their own value Generally speaking the prognosis is good in the absence of renal impairment

Treatment—A Expectant Patients who have (1) an early and a slight enlargement (2) a residual urine of less than 4 oz. (3) a sterile urine (4) a normal renal efficiency and (5) a frequency not sufficiently severe to impair their general condition by lack of sleep can safely be watched They must be warned against chills and intemperance of all kinds and be re-examined every three months to check their residual urine renal efficiency and general condition.

B Operative Patients who have (1) a residual urine exceeding 4 oz (2) infected urine (3) had acute retention and (4) damaged renal efficiency with failing general health should be advised operation. Those with acute retention will be treated by graduated catheterisation (p 795) the bladder being completely emptied within seventy two hours and thereafter kept empty until a decision as to operating is reached

It must be clearly understood that no removal of the prostate should be attempted until the urea clearance tests have shown a satisfactory renal function. The blood urea must not be above 70 mg per 100 c c of blood. If these tests are not satisfactory a single-stage prostatectomy is out of the question and two courses are open to the surgeon In moderate degrees of renal insufficiency and in the presence of slight infection, the bladder may be drained by an indwelling catheter for several days and irrigated with silver nitrate (1 6000) or oxycyanide of mercury (1 7500) and a course of sulphadiazine begun. After ten days further renal efficiency tests are performed. If these are satisfactory one-stage prostatectomy can be carried out in safety if unsatisfactory suprapubic drainage should immediately be established.

In more advanced cases of renal damage or in the presence of marked infection no time should be wasted before a suprapubic cystostomy is performed

No matter how satisfactory renal efficiency tests may be prostatectomy should never be carried out in the presence of pyrexia, and five consecutive days of normal temperature should be allowed to elapse before operation is considered.

Harris s operation and transurethral resection (p 817) have obviated the use of suprapubic drainage and thereby reduced the complications of prostatectomy There is no doubt that the prognosis has been greatly improved by these methods The selection of operation will depend upon the age of the patient his general condition the presence of sepsis and the size of the prostate Under favourable conditions it would be better to remove the whole prostate and resection therefore is to be preferred in those men who are not really suitable for the major procedure

PROSTATIC OBSTRUCTION WITHOUT ENLARGEMENT —There are two conditions which simulate an enlarged prostate **Young's Median Prostatic Bar** consists in a submucous fibrosis in the base of the bladder just at the entrance of the urethra. It arises in connection with the middle lobe or the subtrigonal glands and is not associated with previous prostatitis **Fibrosis** of the prostate due to chronic prostatitis may also deform the urethral opening These two conditions cause symptoms similar to those of senile enlargement but they can be readily diagnosed with the cystoscope They are treated by transurethral resection

CARCINOMA OF THE PROSTATE

This occurs during the latter part of life from the age of 45 years onwards being of somewhat earlier incidence than the senile enlargement

Pathology.—The tumour is of the hard scirrhous type and only very rarely is a soft growth seen. It spreads by extension to the bladder rectum and pelvic cellular tissues by lymphatics to the iliac glands and by metastases to the liver lungs and especially the bones Microscopically it is usually spheroidal-celled, with much fibrosis but occasionally rapidly growing columnar-celled tumours occur

Symptoms are pain frequency and difficulty of micturition, hæmaturia and rectal ulceration. Pain is felt in the perineum, hypogastrium and down the back of the thighs It is persistent and is not relieved by micturition frequency is not so pronounced as in the senile hypertrophy difficulty may be a prominent feature and will lead eventually to retention hæmaturia is not a frequent symptom but may become persistent rectal involvement will cause pain and tenesmus with the passage of blood and mucus in the stools and later if the sphincter is invaded, a colostomy may become necessary to relieve intestinal obstruction. These growths have a curious tendency to spread either forwards to involve the urethra and bladder base or backwards into the rectum. The symptoms which predominate therefore will be either urinary or rectal, and not until the later stages will both bowel and bladder be involved. Bone metastases may be the first sign and these may take place in the bones of the pelvis by direct spread or in any bone at a distance by vascular embolism They are characterised by being osteosclerotic in type so that their prostatic origin may be predicted frequently from their X ray appearance Further these lesions are accompanied by a rise in the serum acid phosphatase

Rectal examination reveals a very hard, nodular and irregular enlargement of one lateral lobe of the prostate which is fixed. The rectal mucosa does not move over it and an extension may be felt spreading upwards and outwards to the lateral pelvic wall. An important sign is the obliteration of the median groove.

Prognosis.—Many of these growths progress very slowly and patients may live for many months or years Any expression of opinion should be most guarded.

Treatment.—Stilbœstrol has been claimed widely to be an infallible remedy even in the presence of multiple bone secondaries It is given in doses varying between 1 and 5 mg three times a day over a long period and many wonderful results have followed. Its action is somewhat capricious however and a warning is needed against a too optimistic assessment of its value Whereas many men appear to be permanently cured others are not Patients should be warned in advance of the breast-development which invariably occurs during the first few weeks of treatment The following cases are instructive

A man of 55 years was admitted bed ridden, emaciated and believed to be dying Carcinoma of the prostate with multiple bone metastases was discovered and he was immediately put on large doses of stilbœstrol Within twelve days he was sitting up in bed and ten days later put his feet to the ground. One month later he was apparently cured and returned to his own home remaining well for fourteen months. He was then re-admitted and it was found that in spite of continuous stilbœstrol therapy his disease had relapsed completely

A second patient of 60 years was seen with weakness of both legs. Secondaries from a carcinoma of the prostate were demonstrated in his lower dorsal vertebræ and his condition deteriorated rapidly until paraplegia had been established. Stilbœstrol seemed to have no effect and after some weeks in hospital he was transferred to a nursing home near to his own dwelling Three months later his doctor reported that an improvement had suddenly set in power was returning to his legs and that he was beginning to walk. His subsequent progress remains to be followed, but this seems to illustrate a delayed action of stilbœstrol the use of which should be continued in spite of apparent lack of response.

Obstruction to the prostatic urethra if unrelieved by stilbœstrol, should be dealt with by endoscopic resection Deep X ray therapy has also given many wonderful results in the past and should be combined with other methods

Sarcoma of the Prostate *is a very rare condition, seen occasionally* in children and proves rapidly fatal.

The Vesiculæ Seminales.—Infection of the vesicles is either gonococcal or tuberculous and these are dealt with in the chapters on venereal infection (p 60) and genital tuberculosis (p 50)

OPERATIONS ON THE PROSTATE

Prostatectomy—Removal of the prostate is performed usually by the suprapubic and only rarely by the perineal route Certain different methods are available

1 Enucleation with suprapubic drainage (Freyer's operation) The bladder being opened by a suprapubic incision, the right index finger is inserted into the gaping mouth of the prostatic urethra on the apex of the middle lobe, while the left is passed into the rectum, where it steadies the gland against the intravesical manipulation. The right index tears a hole in the mucous membrane over the projecting prostatic lobe and enters the submucous layer It can now be swept easily around the prostate, first *the middle lobe* and then *passing deeper the lateral lobe* *Finally* the whole gland is free but for the urethra. The enucleation is completed by tearing across the urethra below the gland, which can then be brought out through *the incision. A large drainage tube is placed in the bladder and the wound* sewn up around it The disadvantages of this procedure are the absence of control of hæmorrhage and the persistence of a suprapubic urinary fistula for periods varying from fourteen to twenty-eight days or even longer Nevertheless in patients whose renal damage demands a two-stage procedure it will remain with minor modifications the method of removal at the second stage

2. Enucleation with bladder closure (Harris's operation) The prostate having been shelled out as described above its bed is exposed by the use of illuminated retractors and all bleeding points are ligated A flute-tipped rubber catheter is then introduced via the urethra and made to enter the bladder The prostatic bed is now obliterated by a number of sutures which pass in front of the catheter In this way the floor of the bladder is reconstituted and the cavity from which the prostate has been enucleated closed to a certain extent The bladder is most meticulously sutured without drainage The layers of the abdominal wall are brought together and a

small rubber tube drain is placed in the cave of Retzius. Drainage of urine by indwelling catheter is maintained for seven to ten days, by which time the wound has healed and normal micturition is re-established soon after the catheter is removed.

3 Harris's operation with temporary suprapubic drainage. In the original operation clot retention proved so troublesome to many surgeons that they modify the operation by placing a small flanged catheter in the suprapubic wound of the bladder, the walls of which are stitched tightly around it. It is my practice to fix up a continuous saline drip through the suprapubic and out of the urethral catheter. The suprapubic drain is removed after seventy-two hours, the wound remains dry and heals by first intention with the result that ultimate healing is as expeditiously achieved as in the original technique without its attendant anxieties.

4 Perineal prostatectomy is rarely practised in this country to-day, but the prostate can be approached by this route when required as for example in the removal of calculi from a fibrous gland. A curved incision is made in the perineum with its concavity towards the anal margin. The dissection is carried down through the central point of the perineum, then onwards between the bulb and the rectum until finally the latter is separated from the posterior aspect of the prostate. Incisions on either side of the middle line enter the lateral lobes.

5 Transurethral Resection. MacCarthy's resectoscope comprises an illuminated optical system giving direct vision into the bladder and a platinum loop activated by a current of high oscillation, the whole being enclosed in a bakelite sheath. The intravesical projection and that part of each lateral lobe proximal to the ejaculatory ducts are removed piece-meal by a series of cuts with the loop, the object being to remove sufficient tissue to restore the calibre of the normal urethra. An indwelling catheter remains *in situ* for seven days, after which normal micturition will be re-established. Some urologists prefer to use a cold cutting blade instead of the electrified loop.

6 Millin's Extravesical Operation. Recently Millin has advocated that the bladder need not be opened, but exposed suprapubically and mobilised sufficiently for it to be retracted backward. Dissection is carried along the sides to the base and the prostatic plexus of veins identified. These are doubly ligated and the capsule incised between the ligatures. Each lateral lobe can be enucleated in this way. If it were possible to perform this operation without in any way damaging the mucous membrane of the bladder or urethra it would mark a considerable advance in prostatic surgery. As it is, clot retention seems to follow in a somewhat high percentage of cases and it is doubtful if this procedure has any real advantage over a modified Harris operation.

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CHAPTER XXXVII

THE PENIS AND URETHRA

SURGICAL ANATOMY.—The Penis serves a double purpose genital and urinary It is composed of three cylindrical bodies of erectile tissue, one of which transmits the urethra. These are bound together by a sheath of fibro-elastic tissue named Buck's fascia and are covered by skin and subcutaneous tissue The two corpora cavernosa arise in the crura of the penis from the ascending rami of the ischium, and meet below and in front of the symphysis. Thence they run parallel and fixed together to meet the glans. The corpus spongiosum fits into the groove on their ventral surface and has two expanded extremities. The anterior forms the glans which caps the ends of the corpora cavernosa and the posterior expansion is the bulb which lies between the crura The skin moves freely over the whole organ, and at its extremity is prolonged over the glans to form the prepuce, at the edge of which it is reflected back to unite with the mucous membrane of the glans at the coronal sulcus. The two layers are separate and allow of retraction and uncovering of the glans The prepuce is connected to the under surface of the glans by a fold of mucosa named the frenum containing the frenal artery **The Urethra** is divided into prostatic, membranous and bulbo-penile parts. The prostatic urethra lies within the prostate is 1¼ in long and is directed downwards and slightly forwards It is of reniform shape on cross-section and along its posterior wall runs an eminence the verumontanum, on the surface of which open the utricle and ejaculatory ducts The membranous part lies between the layers of the triangular ligament and is surrounded by the compressor urethræ muscle It is directed downwards and forwards, and its anterior wall is ¾ in. long the posterior wall being slightly shorter owing to the obliquity with which it enters the bulb Cowper's glands lie behind and external, but their ducts run parallel to it and enter the bulb The bulbo-penile part is surrounded by the corpus spongiosum and varies between 6 and 7 in. at rest and 8 and 10 in. when erect The bulbous part runs directly forwards making an angle of 93 degrees with the membranous urethra and is fixed. It becomes the free or penile part at the penoscrotal junction. When flaccid the urethra forms an S curve Its calibre varies as follows —

Prostatic urethra—beginning and end		[illegible] in.
" middle		[illegible] "
Membranous urethra		[illegible] "
Bulbo-penile—Cul-de-sac of bulb		[illegible] "
" Main channel		[illegible] "
Fossa navicularis		[illegible] "
External meatus	about	[illegible] "

The least distensible portions are the external meatus and the membranous

Internal Structure.—The lining membrane is columnar-celled except in the *fossa navicularis, and the prostatic portion in which it is squamous and*

transitional respectively The roof and sides and to a lesser extent the floor are studded with the openings of the glands of Littré The ducts of Cowper's glands open on the floor of the bulb 1 in in front of the triangular ligament The membranous urethra opens into the roof of the bulb and the cul-de-sac of the bulb extends back ½ in. beyond the opening thus presenting a dangerous area for false passages This part of the bulb is the most low lying of the whole tract and it is in this position that pus collects in urethritis The penis is supplied with blood by the deep internal pudic artery and by the superficial external pudic artery The lymphatics go to the inguinal and deep femoral glands and to those on the external iliac vessels

Clinical Divisions of the Urethra.—A more useful clinical description is to use the compressor urethræ muscle as the dividing line between an anterior and a posterior urethra. The differences between them can be thus summarised (Barringer) —

Anterior Urethra	*Posterior Urethra.*
Surrounded by erectile tissue (corpus spongiosum) for entire length, excepting for ½ in. in the roof of the bulb.	No erectile tissue covering
Many glands of Littre in roof and sides.	Very few glands of Littre
Ducts of Cowper's glands enter bulb.	Ducts of prostatic glands enter prostatic urethra. Verumontanum with ducts of seminal glands in prostatic urethra.
External urinary tract in free communication with the surface of the body and harbours all the micro-organisms that may be thereon.	The lowest section of the aseptic internal urinary tract—entirely free from bacteria, harboured by anterior urethra.
Fixed at one end only (triangular ligament), therefore can assume any curve (*e g.*, on passing a sound) without causing pain to the patient	Fixed at one end by the triangular ligament and at the other by the prostate so having a fixed U curve which when straightened (for example on introduction of a cystoscope) causes pain to the patient
Fluid may be introduced into anterior urethra and held there by compressing urethral meatus	Fluid cannot be retained in posterior urethra. The compression of the surrounding muscles drives it either back into the bladder or forward into the anterior urethra.
The introduction of a foreign body (*e.g.*, fluid or catheter) into the anterior urethra causes only pain or burning	The introduction of a foreign body (fluid or catheter) into the posterior urethra causes pain plus a desire to micturate
Inflammation causes simply pain.	Inflammation causes pain plus frequency of micturition.
There are no voluntary muscles surrounding the anterior urethra which can resist the introduction of a fluid or an instrument	By means of the perineal muscles the introduction of an instrument or fluids can be voluntarily resisted; therefore as the sound or catheter approaches the posterior urethra, manipulations must be very gentle.

Clinical Examination.—The penis is available for digital examination in its whole length as is the urethra the prostatic and membranous portions being approached by a finger in the rectum (For ease and accuracy the presence of a bougie *in situ* is of great assistance) Bougies of metal or gum elastic of the acorn tipped type demonstrate

strictures stones and other lesions The urethroscope allows direct vision of the entire length of the urethra It carries a lamp at the beak, and the hollow tube is closed by a window at the top The urethra is first distended by air when it can be thoroughly investigated

CONGENITAL ANOMALIES

Double Penis is very rare only about thirty cases being recorded, all of which were accompanied by some other defect of the genito-urinary system **Complete absence** is rarer still **concealed penis** implies a small penis lying beneath the scrotal skin A **webbed penis** is attached to the scrotum along its ventral surface and can be freed by a simple plastic operation **Occlusion of the urethra** is due to membranes or folds of mucosa near the fossa navicularis or in the prostatic urethra this condition may be combined with urine being passed into the rectum Division and bougie treatment or even a plastic operation may be needed.

Hypospadias is a defect of the anterior urethra whereby the canal fails to reach the external meatus and according to the position of the opening may be termed glandular penile or perineoscrotal The posterior urethra is always intact and sphincter control is perfect. The perineoscrotal variety fortunately rare is accompanied by a cleft scrotum, imperfectly descended testes and a condition of pseudo-hermaphroditism In the other types a well marked groove between the opening and the meatus represents the imperfectly formed roof of the canal In the glandular cases nothing need be done, and for the other penile types a variety of plastic operations has been described.

Epispadias is a far more serious defect and is very rare The urethra lies on the dorsal surface of the corpora cavernosa and the roof is wholly or partly missing In the former an ectopia vesicæ and separated pubic bones are present, while in the latter the canal opens somewhere on the dorsal surface In all these cases sphincter control is imperfect. Young s operation brings about, by a reconstruction of the penis and urethra an almost normal appearance

THE PENIS

PHIMOSIS

Phimosis may be congenital or acquired and consists in an inability to retract the prepuce over the glans penis due to smallness of the preputial opening unusual length of the foreskin or adhesions.

Congenital Phimosis.—In infants the inner layer of the prepuce is slightly adherent to the glans through the medium of a fine epithelial tissue which disappears during the first two years Later the normal foreskin can be retracted over the glans and slips back without difficulty and without interfering with its blood supply even during erection The prepuce may be short or abnormally long In early years phimosis is of no importance unless it gives rise to complications but later

difficulties during erection and coitus render treatment necessary The complications are —

(a) Difficulty of and pain on micturition, due either to a small preputial opening or to this and the meatus being out of alignment.
(b) Retention of urine either in the bladder leading to back pressure and bilateral hydronephrosis or in the preputial sac leading to balanoposthitis and preputial calculi.
(c) Herniæ or prolapse of the anal canal, due to excessive straining.
(d) Paraphimosis
(e) Difficult and painful coitus sexual neurasthenia.
(f) Carcinoma of prepuce or glans

Acquired Phimosis.—This may be temporary when inflammatory lesions, *e.g* gonorrhœa, chancre or other sores narrow the opening and retraction is impossible or permanent as a result of scar formation produced by the healing of the foregoing lesions It is this type which predisposes to carcinoma.

Treatment —In an attack of balanoposthitis treatment is limited to an incision along the dorsum of the prepuce until the infection subsides Circumcision must be performed as a primary measure in all other cases

PARAPHIMOSIS

This is a condition in which the prepuce has been retracted slips into the coronal sulcus and cannot be returned. Interference with the blood supply by the tight ring sets up a vicious circle The glans becomes œdematous and discoloured, and the ring becomes tighter until necrosis may occur and spontaneous relief be obtained.

The constricting ring is always hidden by a swollen cuff of the inner skin layer of the prepuce which overlaps it from in front Gangrene of the glans is rare

Treatment —In early cases the prepuce can be reduced by pressure on the glans with the thumbs and traction on the skin with the fingers If this fails an incision into the constricting ring relieves the condition As soon as any accompanying infection has subsided circumcision should be performed.

Preputial Calculi are rare and only occur in cases of phimosis with a voluminous prepuce. They may be formed *in situ* from retained urine or from calcification in smegma or passed into the preputial sac per urethram Their presence leads to inflammation and they must be removed and the patient circumcised.

Injuries

Ruptured Frenum.—The frenum may be so short that curvature of the penis occurs during erection, making coitus painful or impossible and leading to tearing of the frenum with profuse bleeding from the artery Simple ligature of the vessel and division of the frenum are required

Injuries of the Penis.—Subcutaneous bruising occurs during erection and usually in connection with coitus It varies from a slight contusion of the skin to a rupture of the sheath of a corpus cavernosum the so-called fracture of the penis In the more extensive lesions there is swelling and pain and damage to or pressure on the urethra causes retention of urine

Treatment—The patient is put to bed, and the penis wrapped in dressings of lead and opium lotion Morphia may be needed for the pain. Usually the blood is absorbed rapidly In grave cases operation must be considered, and becomes imperative if the urethra is torn Tears in the corpora cavernosa will heal more rapidly if sutured, and will be less likely to cause angulation or defects in erection afterwards.

Dislocation of the Penis.—In rare instances the skin of the prepuce is torn away from its junction with the glans and the penis is displaced from its skin covering and comes to lie in the groin or scrotum or in front of the symphysis pubis. The skin hangs down empty in its normal position and blood drips from it or collects in clots inside. Extravasation of urine or retention will follow In treatment the penis is replaced in its skin covering and sutured and injuries to the urethra sought for and repaired

Strangulation by Foreign Bodies.—Strands of hair thread string and metal rings are used either as a means of sexual excitation, to prevent enuresis or as a form of perverted humour The penis swells up distal to the constriction and it is impossible to remove the band except by dividing it which in the case of metallic rings may be difficult

Infections of the Penis

Balanoposthitis.—Acute inflammation of the glans penis (balanitis) and of the prepuce (posthitis) can hardly occur separately and the condition should always be described by the combined name.

The essential factor is a lack of personal cleanliness and additionally there may be venereal infection, retained smegma diabetes, or a chemical irritant as in misguided efforts to prevent infection after illicit intercourse

Symptoms—Burning and itching usher in a swelling of the prepuce which leads to an acquired phimosis Pus drips from the opening and inflamed lymphatics may be palpated running up the penis Later surface ulceration of the glans and prepuce may occur

Treatment—Adequate drainage and access must be ensured by slitting up the prepuce if necessary The irritating cause must be identified and dealt with, and absolute cleanliness insisted upon. Bathing with potassium permanganate (1 8000) is useful. Circumcision is performed after the infection has subsided

Cavernositis.—Acute cavernositis will be described under Periurethral Abscess Diffuse cavernositis is rare is due to pyæmic metastasis or thrombosis and is usually fatal.

Chronic cavernositis may be due to gonorrhoea, syphilis gout or tuberculosis Thickened nodules or plaques appear in one or both

corpora cavernosa and cause great distress as they result in curvature of the penis when erect rendering coitus painful or impossible They are most common after gonorrhœa. In treatment any residual focus of infection in the prostate or vesicles must be searched for and treated. Injections of penicillin may possibly prevent any extension of the plaque or soften the existing fibrosis Surgical treatment is valueless

New Growths of the Penis

There are only two growths worthy of record benign papilloma and malignant carcinoma

Papilloma.—The true papilloma differs in no way from a squamous celled papilloma of the skin elsewhere It should be regarded at or after middle age as precancerous and removed for microscopy

An inflammatory wart is seen as a complication of venereal infection and is described under the complications of gonorrhœa (p 00)

Carcinoma is rare before 40 and most common between 55 and 70 years of age Papillomata and leucoplakia (similar to the lingual) are precancerous conditions Acquired phimosis with a rigid preputial opening rendering the skin liable to chronic irritation, is favourable to malignant change

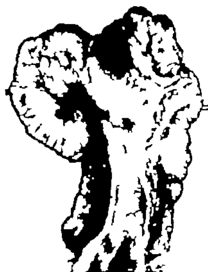


Fig. 397
Squamous-celled carcinoma of penis.

Pathology—Most penile carcinomata start as malignant papillomata on or behind the glans (Fig 397) either on the inner surface of the prepuce or at its opening Infiltration at the base causes a spreading warty growth which does not ulcerate early The thick sheaths of the corpora prevent their involvement until late An ulcer when it occurs has all the characteristics of a squamous-celled carcinoma The growth may erode the prepuce and appear on its outer surface or may open up the urethra with the formation of one or more urinary fistulæ.

The vast majority are squamous-celled, but a few are adenocarcinomata with cubical or columnar *epithelium*.

The inguinal glands on both sides are involved and direct spread to neighbouring structures occurs later As soon as the growth erupts into the corpora cavernosa, spread along the erectile tissue is rapid.

Symptoms—Irritation and discharge are first seen then painful erections swelling ulceration and fistulæ occur In elderly men irritation and discharge with an area of induration to be felt in a penis of normal appearance call for urgent investigation and circumcision should be urged as a diagnostic measure

Treatment.—Two operations are practised, partial and radical amputation.

In early cases, with growths limited clinically to the glans and with a long penis a partial amputation just in front of the scrotum is performed and the glands cleared from each inguinal region. In more advanced cases the whole penis back to the triangular ligament is removed, and some surgeons advise the ablation of the scrotum and testes The urethra must be slit up before implantation into the skin to prevent a stricture forming at the line of suture

Prognosis is fair as these growths tend to be slow-growing

OPERATIONS UPON THE PENIS

Circumcision.—In a young child the undersurface of the prepuce is adherent to the glans penis by soft areolar tissue and under no circumstances should an incision be made into the foreskin until these soft adhesions have been broken down

Two mosquito forceps are placed upon the dorsal margin of the preputial opening on either side of the middle line about ½ in apart These are gently pulled forwards and outwards thereby steadying and making tense the prepuce A probe or blunt dissector is introduced within the prepuce and made to pass along the dorsal aspect of the glans until it reaches the coronal sulcus The probe is then gently swept round one side until it reaches the frenum, when it is made to retrace its steps and the other side is cleared in the same way

An incision is now made with scissors along the mid-dorsal line of the prepuce but it should not be carried further back than mid way between the preputial opening and coronal sulcus. The scissors are turned through 90 degrees and the incision carried round to the frenum thus removing this side of the prepuce Bleeding points are secured and two or three catgut sutures unite skin and mucous membrane The opposite half of the prepuce is similarly treated A small dressing soaked in either lotio plumbi cum opio or tulle gras is applied to the suture line Healing should be complete within a week.

There is a regrettable tendency to remove too much prepuce so that often not only is the glans completely uncovered but there is tension upon the mucocutaneous suture line It may be contended that this matters little whereas in fact it has a serious heritage of sexual troubles later being one of the causes of premature ejaculation Surgical circumcision, as apart from the religious rite aims at giving a preputial opening which will permit easy retraction of the foreskin during erection. A perfect result should leave the proximal half of the glans penis still covered with a preputial cuff

Another common and equally regrettable teaching is that circumcision may be performed by gently drawing the prepuce forward and snipping it off in front of the glans This results too often in a slice of the tip of the glans being removed as well with the result that a pin hole stricture of the external meatus follows.

THE URETHRA

URETHRITIS

The vast majority of cases of urethritis both acute and chronic are gonococcal in origin and are described under that subject Others

are due to the usual pyogenic cocci and *B coli* In the face of denial of the possibility of venereal infection, it is wise to remember that there are other infections of the urethra besides the Neisserian

The *treatment* is identical with that of gonorrhœa (see p 55)

INJURIES

Direct Injuries may occur during the passage of instruments the extraction or passage of stones or other foreign bodies and as the result of penetrating wounds The bulbo-penile urethra is most frequently affected hæmorrhage and occasionally extravasation of urine following Punctures and linear tears need no treatment but if the urethra is extensively torn or divided and if extravasation threatens the wound must be explored and the edges sutured

Indirect Injuries or ruptures of the urethra vary in extent and position. The mucous membrane only may be contused or split or the tear may spread through the outer sheath and into the corpus spongiosum The whole or part of the circumference of the canal may be affected The penile urethra is rarely injured and then only in erection lesions of the bulb occur during falls on the perineum astride a bar or from kicks in this region the membranous part is lacerated by such injuries as produce fractures and dislocations of the bones of the pelvis

Symptoms vary with the situation. Penile ruptures produce severe hæmorrhage some pain on micturition but no retention. Bulbous lesions give less bleeding but a swelling appears in the perineum and there is retention In the membranous urethra the grave general condition of the patient so overshadows the urethral lesion that it may pass unrecognised until retention or extravasation make its presence obvious Extravasation will not occur until an attempt to micturate is made Later extensive bruising in the perineum appears.

Diagnosis—In the majority of cases the type of injury perineal swelling and hæmorrhage make the condition obvious but in those complicating fractures of the pelvis the diagnosis may give rise to grave anxiety So serious is it to leave a ruptured urethra unrecognised that every patient with a fractured pelvis or other similar injury should be suspected of a urethral lesion, and immediate *steps taken* to exclude or treat it. The patient is instructed not to pass his water and an attempt is made with even more than usual gentleness to pass a catheter If this passes smoothly and painlessly and urine free from blood is obtained, and if no bleeding follows its withdrawal a ruptured urethra is improbable

Prognosis—If recognised early there is no danger to life but if extravasation has occurred, the mortality is 40 per cent In every case a traumatic stricture will follow unless prevented by treatment.

Treatment—Open operation is imperative as the future behaviour of the resulting stricture depends directly *on the perfection of* apposition of the edges. Access is gained to the bulbous urethra by a median perineal incision, and to the membranous by a curved transverse one with the concavity forward. A rubber catheter passed down to the

tear will define the distal end. All clot is washed away and the proximal end identified The catheter is then passed into the bladder and the urethra sewn over it the perineum being closed with drainage. The catheter remains *in situ* for a week In complete ruptures the retraction of the proximal end may make its recognition difficult, but it *must* be found, even if this needs a suprapubic cystotomy with retrograde catheterisation. If a length of urethra is missing as in gunshot wounds a catheter is passed as before across the gap and the wound lightly packed and drained. In all cases persistent and prolonged instrumentation is needed to prevent the scar contracting down.

STRICTURE

This may be congenital, traumatic spasmodic or inflammatory

Congenital Strictures occur at the external meatus at the junction of the fossa navicularis with the penile urethra, and in the membranous and prostatic portions The narrow external meatus is the most common and may lead to difficulty in micturition in infancy and to imperfect seminal emissions later The operation of external meatotomy consists in an incision in the floor towards the frenum the mucous membrane being stitched to the skin of the glans

Traumatic Strictures follow injuries (see above) Fibrosis occurs between the torn ends and unless coaptation be accurate the scar will be widespread and dense

Spasmodic Strictures follow the so-called Saturday night excesses. In every case a moderate degree of organic stricture is present to which is added a congestion of the mucous membrane leading to acute retention

Inflammatory Strictures occur between the ages of 20 and 55 years, and 98 per cent follow gonorrhœa Tuberculosis diabetes and urethral chancre account for the remainder

Pathology—In an attack of urethritis the infection spreading to the glands in the urethral wall, may be imperfectly drained As a result the inflammatory process spreads to the submucous coat and finally into the corpus spongiosum On the subsidence of the resulting periurethritis a scar forms the contraction of which leads to a narrowing of the canal The majority of strictures occur in the bulbous urethra within an inch of the opening from the membranous This is the most dependent part of the fixed urethra where drainage is least efficient. Strictures never occur primarily in the prostatic urethra but the fibrotic process may spread backwards from the bulb Although, clinically strictures may appear multiple the several constrictions are integral parts of a single pathological process

Types of Stricture—*Annular* affects the whole circumference *Bridle* affects part of the wall only and stretches across the lumen *Cartilaginous Massive* and *Palpable* refer to size and consistence *Resilient* denotes those which contract down again quickly after easy dilatation *Permeable* when urine can be passed *Passable* and *Impassable* refer to the passage of catheters The lumen may be central or eccentric straight or tortuous

Pathological Results—These have been dealt with under Retention

of Urine (p. 807). They are hypertrophy, trabeculation and sacculation of the bladder with bilateral hydronephrosis and later infection of the kidneys with failing renal function. The urethra proximal to the stricture is dilated and thickened and false passages, periurethral abscess and fistula may be seen.

Symptoms are a history of gonorrhoea, probably a slight chronic discharge, difficulty in micturition, some frequency aggravated by sexual and alcoholic excess and later acute retention. Straining is necessary to start the act and the stream is of small volume and slow. The act does not end abruptly and cleanly but the last ounce dribbles away often after apparent cessation. Alteration in the shape of the stream is of no diagnostic importance.

Complications are acute retention, sepsis throughout the genito-urinary tract, extravasation of urine, fistula, stone and carcinoma of the urethra.

Diagnosis.—A stricture is identified by passing bougies and by the urethroscope.

Treatment rests between dilatation and operation.—*A.* Dilatation.—Most strictures can and should be dealt with by dilatation, of which there are three methods, viz. intermittent, continuous and rapid. Intermittent dilatation—the method of choice—consists in a well regulated technique lasting over a period of years. At the start of treatment the largest bougie which will comfortably traverse the stricture without undue resistance is passed. Every third day bougies of gradually increasing size are used until 25 to 30 F. is reached. After this the full-size bougie is passed once a fortnight for three months, once a month for the next six months, then every third month for a year. The patient should then be seen twice yearly. Continuous dilatation is used in cases of acute retention complicating a tight stricture. A filiform bougie is passed and left *in situ* for twelve hours, the urine trickling slowly alongside it. The stricture will now admit a larger bougie and this also is left in for twelve hours, at the end of which time the stricture is suitable for the commencement of intermittent dilatation. Rapid dilatation is performed by a special expanding metal instrument—the Kohlmann dilator. Its use should be reserved for selected cases in expert hands, as much harm can be done by ill judged rapidity.

B. Operative Treatment should be employed only in cases unsuitable for dilatation. Thomson Walker classified these as follows:—

1. Dilatation has been tried and failed.
   (*a*) Cartilaginous, resilient or irritable strictures.
   (*b*) Hæmorrhage after dilatation.
   (*c*) Recurrent epididymitis or retention after passage of bougies.
2. Dilatation unsuitable.
   (*a*) Impassable stricture.
   (*b*) Urethral complications such as stone, periurethral abscesses, extravasation or fistula.
   (*c*) Other complications demanding treatment, *e.g.* enlarged prostate, vesical stones, infections or growths.

The following operations are practised —

1 INTERNAL URETHROTOMY consists in division of the stricture by a specially designed knife working within the urethra. The stricture must be passable as all types of urethrotome depend upon the passage of the leading part of the instrument through it In the Otis urethrotome the knife is concealed among the blades of a dilator in the Teevan and Maisonneuve instruments a whalebone or gum-elastic guide serves to direct the knife to the stricture The incision is made in the roof of the urethra, because here a too deep cut will merely enter the septum between the two corpora cavernosa and not open up the corpus spongiosum which would lead to abscess formation. Intermittent dilatation follows the operation. In spite of many superficial attractions, this operation should be restricted to passable resilient strictures in the penile portion only in which the degree of sepsis is slight, of low virulence and confined to the urethra.

2 EXTERNAL URETHROTOMY WITH A GUIDE (Syme s operation) This operation also requires that the stricture be passable so that the narrower extremity of the Syme s shouldered staff can be passed through it. The urethra is opened through the perineum just distal to the stricture which is divided by running the knife along the groove in the staff. A No 16 rubber catheter is passed down the urethra, guided through the stricture area and on into the bladder and left *in situ* for seven days while the wound granulates around it. The after treatment consists in full intermittent dilatation This operation is reserved for passable strictures in the bulbous urethra, which have failed to yield to instrumentation.

3 EXTERNAL URETHROTOMY WITHOUT A GUIDE (Wheelhouse s operation) is the operation of choice for all impassable strictures. The Wheelhouse grooved staff is passed to the face of the stricture and the urethra opened on the groove The cut edges are widely retracted and the lumen of the stricture sought for A filiform bougie is passed through it the fibrosed area divided along the bougie and a silver perineal tube introduced into the bladder The usual after treatment by intermittent dilatation follows the healing of the wound In some cases the most careful search fails to reveal the proximal opening and retrograde catheterisation through a suprapubic opening is needed to identify the urethra above the stricture.

4 RESECTION OF THE STRICTURE is admirable in theory but disappointing in practice and can only be done in very short strictures. Cabot s plastic operation divides the stricture longitudinally and sews it up transversely

5 EMERGENCY METHODS to relieve acute retention. In impassable strictures with retention, when circumstances render operation difficult to arrange for some hours the distension of the bladder may be sufficiently great to demand relief Suprapubic puncture above the pubes with a trocar and cannula is suitable for cases with no urinary infection and can therefore only be used in early cases without cystitis. In all others a suprapubic cystostomy gives adequate drainage prevents the possibility of abscess formation in the abdominal wall and further permits retrograde catheterisation in difficult cases Cock s perineal puncture to-day is of historical interest only

PERIURETHRAL ABSCESS

The infection is urethral in origin the organisms being the gonococcus staphylococcus streptococcus or bacillus coli and is in many cases mixed. It may occur during an acute attack of gonorrhoea follow infection behind a stricture or a foreign body or be associated with false passages from faulty instrumentation, an indwelling catheter or carcinoma of the urethra It may affect either the penile or bulbous portion

Symptoms —A small hard nodule appears in the floor of the urethra and enlarges towards the surface The skin becomes red tender boggy and finally fluctuant If untreated it may rupture either on to the surface into the urethra, or both ways, in which last case a urinary fistula is formed The signs of general toxaemia vary some cases being ill with rigors and a high temperature while in others the onset is more insidious Complete or partial retention is common

Treatment —The abscess should be opened as soon as diagnosed A median incision in the line of the urethra will permit of access to break down all pockets and secure adequate drainage thus preventing the danger of urinary fistulae formation The coexisting stricture or urethritis must also be dealt with.

EXTRAVASATION OF URINE

This is due to rupture of the bladder or urethra The former has been described (p 797) Rupture of the urethra may be traumatic but in many cases extravasation occurs behind a stricture Only rarely does it follow a periurethral abscess The attachments of Colles s fascia to the triangular ligament and of Scarpa s fascia to the deep fascia in the thigh determine the direction of spread of urine thus it will track along the perineum into the scrotum along the spermatic cords to the thigh and anterior abdominal wall and between Scarpa s fascia and the muscle sheaths It also follows the cord along the inguinal canal and enters the subperitoneal planes Fortunately the incidence of this serious condition has greatly decreased in the last twenty five years and it is now rarely seen

Symptoms —The determining factor is evident in the history The onset is abrupt being ushered in by a rigor and perineal pain. The temperature rises to 103° F or more and all the signs of toxaemia are early apparent Urine is passed in small quantities and with difficulty and there may be some urethral bleeding A *swelling* appears in the perineum and spreads rapidly to the penis scrotum abdominal wall and thighs. In the early stages it is dull red brawny and indurated while in neglected cases gangrene and sloughing of the skin occur and urine trickles slowly away *A fatal* ending is common.

Treatment consists in immediate multiple incisions throughout the indurated area These must be carried through the fasciae of Scarpa and Colles and adequate drainage obtained If possible a catheter is passed per urethram into the bladder and if this fails the urine must be side-tracked by a suprapubic cystotomy

URETHRAL FISTULA

This may be congenital traumatic inflammatory or neoplastic. The congenital are associated with hypospadias and epispadias, or combined with other malformations such as an imperforate anus The traumatic and neoplastic types are very few The majority are the result of an imperfectly drained periurethral abscess, but other inflammatory causes are prostatic and perianal abscesses and gummatous ulceration in the perineum

The urine is voided only during the act of micturition and, as the openings are frequently multiple the discomfort of a spray like effect can be well imagined Treatment is difficult and often unsatisfactory Any co-existing condition must be treated and after excision of the fibrosed area an attempt is made to close the defect by plastic flaps.

URETHRAL CALCULI

These may be formed in the urethra or arrested there during transit. Provided the urethra is normal their passage should be certain though painful. If impaction occurs the stone should be pushed back into the bladder and removed with a Bigelow s evacuator If a stricture is present an external urethrotomy will be necessary

FOREIGN BODIES

An oddly assorted collection of foreign bodies may be passed into the urethra Pain, burning and hæmorrhage are present and aggravated by erection later a purulent urethritis probably follows. If allowed to remain, phosphatic incrustation and periurethritis occur They may be removed through a urethroscope or pushed on into the bladder and removed thence

URETHRAL GROWTHS

All growths are rare but a benign papilloma and hæmangioma are described Carcinoma apart from the penile type occurs between 45 and 70 years of age and may be squamous or columnar-celled It is first noticed by urethral bleeding and some difficulty in micturition. A hard mass can be felt and later invasion of the corpus spongiosum and of the skin leads to urinary fistulæ. A radical amputation of the penis is required

R M Handfield-Jones

CHAPTER XXXVIII

THE TESTIS AND SPERMATIC CORD

SURGICAL ANATOMY.—The testes are a pair of oval glands each measuring 1½, 1¼ and ¾ in. in length, breadth and thickness, hanging each in its own compartment of the scrotum with its long axis directed upward and slightly forward and outward. The left hangs lower than the right and both are loosely attached to the bottom of the scrotum by the fibrous remains of the gubernaculum.

The Epididymis, composed of the convolutions of the excretory duct lies along the posterior border of the testis. Its upper expanded end which caps the upper pole is named the globus major. The lower smaller end reaches the lower pole and is called the globus minor while the intervening part is the body. The globus major and minor are firmly attached to the testis by fibrous tissue, and the former is continuous with the testicular tubules through the efferent ducts. The vas deferens emerges from the globus minor to turn upwards and enter the spermatic cord. On the anterior aspect of the globus major or of the superior pole of the testis are two small bodies, the stalked and the sessile hydatids of Morgagni, representing remains of the Müllerian duct. Embedded in the cord just above the testis is a collection of rudimentary tubules, viz. the organ of Giraldes, a remnant of the Wolffian body.

The blood supply is from the spermatic artery and the artery to the vas. The veins enter the cord to form the pampiniform plexus which becomes the spermatic vein at the internal abdominal ring. The spermatic arteries arise from the aorta near the renal arteries. The left spermatic vein enters the left renal vein and the right the inferior vena cava. The lymphatics drain chiefly to the glands on and between the aorta and vena cava. The nerves are derived from the aortic and renal sympathetic plexuses.

The tunica vaginalis is a closed sac which embraces the greater part of the testis and epididymis. It is derived from the peritoneal diverticulum, which precedes the descent of the testicle from the abdomen—the processus vaginalis. It is composed of two layers, visceral and parietal, enclosing a potential cavity. The visceral layer clothes the testis and epididymis and is reflected from them at the posterior border to form the parietal layer which lines the scrotal sac. Between the body of the epididymis and the testis it forms a recess—the digital fossa—and it is prolonged upwards for 1 in. along the cord.

The spermatic cord extends from the internal abdominal ring to the testis, traversing the inguinal canal for the first 2 in. It then passes through the external ring and enters the scrotum. It consists of the vas deferens, the artery to it, the spermatic and cremasteric arteries, the pampiniform plexus of veins, the testicular lymphatics, the spermatic plexus of nerves and the genital branch of the genito-crural nerve. These structures are held together by loose areolar tissue and the whole is contained within the following coverings from within outwards:—

1. The subperitoneal fatty layer
2. The internal spermatic fascia from the fascia transversalis
3. The cremasteric fascia from the internal oblique muscle,
4. The external spermatic fascia from the external oblique
5. The dartos tissue
6. The integument.

The testis normally lies behind below and internal to the tunica vaginalis, but sometimes the relations are reversed and it lies above in front and external.

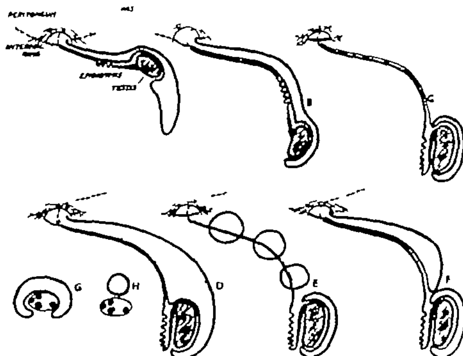


Fig [illegible]

The relation of the peritoneum to the descent of the testis. The potential sites of hernia and hydrocele formation.

A, the preceding peritoneum during testicular descent. B patent processus vaginalis. C, complete or normal closure with the epididymis applied to the testis. D potential sites of hernial sac formation. E, potential sites of hydrocele formation F common type of infantile hernia. G, a cross-section of the cord in a congenital sac. Note the sac nearly surrounds the cord. In the female the round ligament constantly shows this relationship. H, the relation of the acquired sac to the cord.

The Descent of the Testis—The testes develop in the abdominal cavity behind the peritoneum at the level of the 1st lumbar vertebra. During fœtal life a slow migration occurs till at birth the testes should be in the scrotum. No convincing explanation of the mechanism which produces this migration has been forthcoming. A brief description of the facts must be given, as without them imperfect descent and certain anomalies leading to congenital hydroceles and herniæ cannot be understood. Attached to the lower pole of the testis is a fibromuscular cord named the gubernaculum, which ends on the posterior surface of the anterior abdominal wall at the site of the future internal abdominal ring. At about the sixth month the testis has reached this point. The inguinal canal is then formed by the

gubernaculum, which penetrates the muscles, taking with it a funnel-shaped diverticulum of peritoneum—the processus vaginalis thus lying anteriorly The trail for the testicular descent is thus blazed by the gubernaculum and processus. The former now gains attachment to the bottom of the scrotum, the external ring and the pubic crest The descent through the canal occurs during the seventh and eighth months, and by birth the testis should be in the scrotum. As it penetrates the abdominal wall it takes with it a covering derived from each layer Later the processus vaginalis is shut off from the peritoneum by closure at the internal ring and finally atrophies and disappears except around the testis and epididymis, where it forms the tunica vaginalis. Anomalies of this closure constitute the varieties of inguinal hernia and hydrocele (Fig 598).

ERRORS IN DEVELOPMENT

Polyorchidism implies the presence of more than two testes The number of proved cases is less than ten. *Anorchidism* partial or com plete is also a very rare condition. *Synorchidism* or fusion between two testes has been recorded on two occasions.

THE IMPERFECTLY DESCENDED TESTIS

The testis may be arrested at any point in its descent or having passed the external abdominal ring it may come to rest elsewhere than in the scrotum This latter condition is more correctly designated Ectopia Testis During the first six months of life incomplete descent can hardly be termed pathological, especially when it is remembered that the cremaster muscle is then so active that the testis can be with drawn into the inguinal canal. No importance need be attached to this condition during the first year In definite cases the incidence is 1 1000 each side being equally affected.

The positions occupied by the testis in imperfect descent (1 2 and 3) and in ectopia (4 8) are —

1 Abdominal or retained testis *i.e* somewhere on the posterior abdominal wall,
2 Inguinal, lying at any point in the canal,
3 Just outside the external ring (the commonest of all)
4 Interstitial, *i e.* related to the abdominal wall either between the peritoneum and the muscles or between or in front of the muscles
5 Pubic on the symphysis pubis
6 Femoral, in Scarpa s triangle
7 Perineal,
8 Transverse *i.e.* both testes in the same canal.

Effect on the Testis

A On its Function.—Spermatogenesis is usually but not invariably absent but the interstitial cells are said to be present The author has observed many cases in which a delayed puberty has accompanied imperfect descent

B On its Vulnerability—Imperfectly descended testes are more

liable to injury and torsion There is little real evidence that they are more susceptible to infection and new growth. A retained testis is a source of danger in that it is less accessible to diagnosis and hence liable to unrecognised complications.

A congenital inguinal hernia invariably accompanies varieties (2) and (3) above and often coexists with types (4) to (7)

Treatment—Some diversity of opinion exists as to the most suitable age for operation Should a testis be immediately outside the external abdominal ring its vulnerability in boys at preparatory school playing football and cricket is probably sufficient justification for operation in this age period Apart from this there appears to be little reason for surgical treatment until the age of puberty for up to this time some prospect of the testes descending normally into the scrotum remains and the chances of this are to some extent increased



Fig 399

Author method of fixation after operation for imperfectly descended testis.

by the use of Progynon Pregnyl or some other similar endocrine extract It must be understood however that these drugs should not be used until puberty is at hand. Their earlier exhibition has led to unfortunate examples of premature development of secondary sexual characteristics at an embarrassingly early age When the boy has reached the age of 15 years and has not improved after endocrine therapy operation must be advised.

Three operations are possible orchidopexy orchidectomy and abdominal replacement The last should never be practised and removal of the testis is rarely necessary Orchidopexy which consists in fixation of the testis to the scrotum, should be attempted The shortness of the cord is the one factor leading to difficulty It is, therefore dissected up to the internal ring and each layer of its coverings divided Traction on the testis will usually suffice to bring it well down into the scrotum There are many methods of fixing it in its new position, but it is the author s practice to sew the testis to the floor of the scrotum and to leave the sutures sufficiently long to reach the level of the knee A small metal plate carrying a brass hook is incorporated in a plaster-of Paris bandage around the thigh immediately above the knee and to this hook the ends of the suture are tied (Fig 399) In this way the testis is prevented from retracting up into the inguinal canal for ten days after which time it will remain in place without difficulty In those rare cases in

which the testis cannot be brought into the scrotum without undue tension then orchidectomy is preferable to abdominal replacement In ectopia testis it will be easily realised that there is no shortening of the cord and therefore replacement in the scrotum presents no difficulties

Torsion of the Testis

Torsion may occur at any age but is most frequent in adolescence Two distinct varieties occur

Torsion of the Cord occurs in association with an imperfect descent of the testis which lies just outside the external abdominal ring Owing to the shortening of the cord the testis is held somewhat firmly against the pillars of the external ring Should the testis twist this tension is further increased and as a result the normal testicular mobility is lost and untwisting cannot occur Some minor strain or injury may precipitate the attack but cases have occurred during sleep

The cord below the twist is congested and the vessels thrombosed the testis is intensely congested develops interstitial hæmorrhages and resembles blood clot in appearance Gangrene and infection are likely to follow in untreated cases (Fig 400)



Fig. 400
A specimen illustrating the effects of strangulation of the testis due to torsion of the cord.

Symptoms and Diagnosis — There is a sudden onset of severe pain in the testis which becomes swollen and tender An attack of vomiting is common When torsion occurs in a testis lying at the external ring, the condition is likely to be mistaken for a strangulated inguinal hernia

Intravaginal Torsion of the testis is less common and occurs in association with a normally placed organ, but a long mesorchium is present and polar rotation has not taken place (Fig 400) This type of lesion usually occurs during the third decade of life and many patients give a history of strain due to lifting heavy weights and there is never direct trauma to the testis. Its condition is similar to that described above but the cord and tunica vaginalis are unaffected

Symptoms and Diagnosis —Pain is of slow and gradual onset usually wakening the patient during the night following the strain. Within forty-eight hours pain, swelling and tenderness are well marked but the picture is not so severe as in torsion of the cord and as a result acute epididymo-orchitis is likely to be diagnosed

Treatment of both varieties is immediate operation at which the

twist is undone and the testis replaced if viable, or removed if too severely damaged to recover

INJURIES TO THE TESTIS

The testes are by their position peculiarly vulnerable yet their extensive mobility usually protects them from serious damage Sub cutaneous trauma is usually seen as the result of games injuries or rarely falls from astride beams etc Two distinct lesions result traumatic orchitis and hæmatocele (p 848) The one symptom is severe pain the patient having a distressing feeling that he may faint at any moment The testis swells up rapidly and the tunica vaginalis fills with blood Treatment for the hæmatocele is discussed later but the orchitis needs rest evaporating lotions, suspensory bandaging and morphia in the early stages The most scrupulous attention to cleanliness of the parts must be observed to prevent infection penetrating the skin.

INFECTIONS OF THE TESTIS

These may be classified as follows —

A Acute
1. Pyogenic from direct implantation
2. Pyogenic from urethra or prostate
3. Pyæmic
4. Metastatic in certain specific infectious fevers,
5. Gonococcal
6. Due to *Bacillus coli*

B Chronic
1. Following acute cases, i e imperfect resolution
2. Primary chronic pyogenic
3. Tuberculous
4. Non-specific
5. Syphilitic

Method of Infection —This question is one of great controversy Firstly there is the localisation of certain infections to the epididymis and of others to the body of the testis This is an example of that selective propensity of bacteria which is seen in other parts of the body and for which there is no satisfactory explanation Secondly there is the problem of the route taken by the infecting organisms—[illegible] the blood stream lymphatics or vas deferens

1 Hæmatogenous Certain infectio[illegible] indisputab[illegible] that blood-stream infection does occur [illegible] rchitis of of syphilis.

2. Genito-urinary lymphatic invas[illegible] elations the genital and urinary systems in [illegible] prostatic urethra is th[illegible] common meet[illegible] all t[illegible] both systems. In [illegible] the uret[illegible] tory multiple prostatic [illegible] the base of [illegible] In that small ar[illegible] infective [illegible] to attack any or [illegible] and [illegible] reach this area dow[illegible] e remain[illegible] The prostate semin[illegible] both to infect each other [illegible]

out of all proportion to their local significance because of the grave possibility of the process spreading to the bladder base and so reaching both kidneys. If the surgery of genito-urinary infections is to be properly appreciated this interrelationship must be continuously borne in mind. In this type of spread the transmission is not up the lumen of the vas but along its lymphatics. The infection is carried by the vasal and perivasal lymphatics from the prostate or vesicles to the testis. Spread along the lumen of the vas by retrograde peristalsis is not possible (p. 799)

Acute Orchitis

This may be seen as the result of penetrating wounds or of injury without breach of scrotal skin. It may occur very rarely in pyæmia from osteomyelitis and other acute infective conditions. It may also complicate gout the attacks corresponding to the exacerbations in the joints.

It is a complication of certain specific fevers *e.g.* typhoid, small pox, glanders scarlet fever influenza, malaria and most commonly mumps. About the tenth day of the parotitis a swelling of one or both testes occurs with considerable pain. The gland is enlarged, hard and tender and a small flabby hydrocele is present. Suppuration never occurs and the swelling subsides in seven to ten days. Atrophy of the tubules may occur and in bilateral cases sterility is likely to result. The treatment consists in rest in bed, local applications of lead and opium lotion and a suspensory bandage.

Acute Epididymo-orchitis

This may be of pyogenic gonococcal or coliform origin.

Pathology.—The infection primarily in the urethra or prostate reaches the epididymis by the lymphatic route and settles first in the globus minor from which the whole epididymis is affected and spread into the testis occurs along the efferent ducts.

A **Pyogenic Cases** follow infection behind a stricture false passage periurethral and prostatic abscesses. It is seen also as a complication of prostatectomy. Suppuration usually results and the testis will be destroyed. Early orchidectomy is the correct treatment.

B **Gonococcal Epididymo-orchitis** occurs during the second or third week of an acute attack of gonorrhœa or more rarely during the chronic stage. The onset is abrupt, slight pain being felt in the globus *minor* but this rapidly spreads to the entire gland and becomes severe. The swelling attacks first the epididymis then involves the body of the testis and finally the scrotal skin becomes red, glazed and œdematous. A small hydrocele may form. The swelling is exquisitely tender and the patient suffers from fever and malaise. In the early stages examination will reveal no changes in the prostate or vesicles. With the onset of the testicular lesion the urethral discharge ceases, and is not re-established until the swelling of the testis has subsided. The diagnosis is rarely in doubt.

Treatment.—All local treatment to the urethra must cease immediately. The patient is put to bed with local applications of lead and

opium lotion or glycerin and belladonna, and the scrotum is supported. Penicillin therapy has superseded all other forms of general treatment. When the swelling subsides a small fibrous nodule is apt to remain in the globus minor. When the urethral discharge reappears its treatment must be resumed. Fibrosis in the epididymis may result and when bilateral sterility may follow.

C **Coliform Infections** are described on p 840 under the title of Non-Specific Infections.

TUBERCULOUS EPIDIDYMITIS

This disease occurs at any age but the third decade is the commonest period. Each side seems equally liable to infection. The method of infection is disputed, some observers declaring that every case is secondary to a focus in the prostate or vesicles, others maintaining that the majority are blood borne. The subacute form is always hæmatogenous but in chronic cases 60 per cent are lymphatic in origin. The original tuberculous lesion is in the lungs or lymph glands.

Tuberculosis of the epididymis assumes an importance out of all proportion to its local effects owing to the intimate interrelationship between testes, prostate, bladder and kidneys. A lesion in one epididymis may reach both kidneys and effect a fatal result. The pathological changes are:

A **In the Epididymis.**—The histology differs in no way from that of tuberculosis elsewhere. The first nodule starts in the globus major or minor according to the route of infection and spreads throughout the whole epididymis. This becomes enlarged, thickened and studded with tubercles which eventually coalesce to form large caseous areas.

B **In the Testis.**—The infection later reaches the testis by the efferent ducts. This takes place early and extensively in the subacute type but very late in the chronic type. A small hydrocele may be present.

C **In the Cord.**—The vas becomes thickened, enlarged and hard, the rest of the cord being unaffected.

D **The Seminal Vesicles** become enlarged and nodular and peri vesiculitis obliterates the transverse groove between them and the prostate.

E **The Prostate** becomes slightly enlarged on the affected side, irregular, hard and nodular.

In the primary epididymal cases the changes in the vas and prostate follow the testicular lesion, whereas in those patients in whom the lesion is secondary to disease in the upper genito-urinary tract they are present before the epididymis enlarges. In the primary cases it may be possible to feel the uppermost limit of the spread in the vas.

Clinical Varieties—Two distinct varieties occur, the subacute and the chronic.

Subacute Tuberculous Epididymitis (Fig 401) is of sudden onset in a man usually known to have pulmonary or other tuberculosis. In a

small percentage of patients there will have been a transient mucopurulent discharge from the urethra at some time during the six weeks preceding the testicular swelling



Fig. 401
Subacute tuberculous epididymitis, the caseous abscess having erupted through the lower pole into the dartos tissues beneath the skin. The vas is thickened.

The pain is moderately severe and the epididymis becomes swollen The scrotal skin soon becomes adherent and then red and œdematous Within six weeks an abscess is obvious and may be threatening to break through the skin, and this will certainly happen if early treatment is not carried out The vas may be thickened for a variable distance but no signs of prostatic or vesicular invasion can be felt On removal the testis is seen to be involved

Chronic Tuberculous Epididymitis (Fig 402) is of such insidious onset that the patient finds it difficult to say when the disease started Slight aching pain may have been the first symptom or a nodule been felt when bathing This nodule may be in the globus major or minor and invasion of the whole gland will take months Fixation to the skin is a late sign. The vas is thickened and nodular but the rest of the cord is normal. Rectal examination reveals the typical signs of prostatic and vesicular invasion.

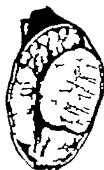


Fig. 402
Chronic tuberculous epididymitis. The epididymis is enlarged throughout and caseous tubercles are seen. The vas is thickened.

Treatment—In the subacute type orchidectomy must be performed at once, because there is a good prospect that the testicular lesion is the only genito-urinary one further the abscess will invariably rupture through skin if untreated and a persistent sinus will remain

In the chronic type the treatment depends on the extent of the spread There are certain contraindications to operation viz. (*a*) bilateral epididymitis (*b*) advanced tuberculosis of the prostate (*c*) tuberculosis of the urinary tract (*d*) active and advanced tuberculosis elsewhere If operation is decided upon there are varied procedures available Epididymectomy is directed to the removal of the epididymis leaving the body of the testis and its blood supply intact but in practice the blood supply is usually damaged and the testis atrophies while there is no guarantee that a few early tubercles have not already appeared in the testis Orchidectomy with removal of the cord as far as the internal ring combined with a digital avulsion of the vas as low down in the pelvis as possible is a more satisfactory operation Subsequent invasion of the opposite epididymis is so frequent that its vas should be divided between ligatures at the same time Sterility must necessarily follow and this must be faced as the lesser of two evils.

In operable cases the full rigour of prolonged convalescent treatment must be enforced on the same lines as laid down for operable renal tuberculosis including the use of streptomycin Even in inoperable cases local measures will be needed in addition to full sanatorium régime if a sinus is established in the scrotum.

Prognosis in the subacute variety is said to be poor If the existence of this type were more universally recognised the diagnosis would be made earlier and immediate orchidectomy would produce greatly improved results. In the chronic cases the prognosis depends on the extent of the genito-urinary spread.

NON-SPECIFIC EPIDIDYMO-ORCHITIS

Prior to 1939 it was recognised that there occurred certain infective processes which bore close resemblance either to acute gonococcal epididymo-orchitis or to a chronic tuberculous epididymitis but the nature and frequency of these lesions were imperfectly understood by the majority of medical men in this and other countries. During the recent war a great number of Service cases were admitted to British hospitals and the pathology of this condition has been placed on a firm basis To avoid confusion the term non-specific epididymo-orchitis has been applied to this group of cases.

Pathology —In the majority of patients *B coli* is the infecting organism which can be isolated from the urine in many cases, although no sign of a urinary infection is present In others no specific organism can be demonstrated.

Clinical Varieties —Two distinct types are seen—acute and chronic.

Acute Non-specific Epididymo-orchitis simulates the lesion produced by the gonococcus but the inflammation is rather less severe and all previous manifestations are absent

Chronic Non-specific Epididymitis mimics a chronic tuberculous lesion so closely that mistakes in diagnosis will continue to be made As a result orchidectomy will be performed and the error exposed by the pathologist

Treatment —Almost all these cases yield rapidly to an intensive course of sulphadiazine

SYPHILITIC ORCHITIS

The testis may be affected as follows —

Congenital		Diffuse interstitial orchitis.
Acquired	Secondary stage	Subacute epididymo-orchitis.
	Tertiary stage	Localised gumma Diffuse interstitial orchitis.

Subacute epididymo-orchitis in the secondary stage is always bilateral and accompanied by hydrocele It is usually transient but may recur if treatment is not adequate

Gumma of the Testis is not very common (Fig 403) It presents a painless swelling of the body of gradual onset often masked by a hydrocele The lesion is confined to the testis the epididymis remaining

unaffected in most cases. If untreated the gumma will spread to the scrotal skin which becomes involved with the formation of the typical ulcer and wash leather slough followed by a hernia of the testis Modern methods of diagnosis should make these latter complications impossible Gummata are occasionally mistaken for growths, but an exact history careful examination and a Wassermann test should make diagnosis easy

Diffuse Interstitial Orchitis is more common always bilateral and accompanied by a hydrocele In the early stages the testes show a rounded, firm painless and heavy enlargement in which sensation is abolished Later fibrosis occurs and they become small hard and heavy out of all proportion to their size

In all types the treatment is that of the causative syphilis.



Fig. 403

Two gummata in the body of the testis with a hydrocele of moderate size

GROWTHS OF THE TESTIS

These may be classified —

Benign	Adenoma
Malignant	Carcinoma Teratoma Sarcoma

Benign growths are practically unknown two cases of adenomata have been reported and the many so-called benign connective tissue tumours are examples of teratomata, in which one tissue predominates



Fig. 404

A testis replaced by a cystic teratoma with an intracystic growth containing skin, hair and bone An example of the rare "dermoid cyst" of the testis

Malignant Growths

Etiology—Testicular tumours are not common Teratomata may be seen in childhood, adolescence and up to 35 years of age while carcinomata occur between 35 and 55 somewhat earlier than the usual age Trauma seems to play a definite rôle as a causative factor

Naked-eye Appearance.—Carcinomata show a wide diversity of appearance of the 10 specimens in the St Mary's Hospital museum no two are alike They tend to maintain the general shape of the testis and to remain within an intact *tunica albuginea* Many grow so rapidly that extensive necrosis of the tumour occurs

Teratomata fall into three groups —

A The single cystic type or "dermoid cyst" in which the testis is replaced by a cyst with an intracystic growth carrying

skin, hair and teeth, etc (Fig 404) The number of cases on record is very small.

B The polycystic type or fibrocystic disease with many small cysts scattered throughout a background of varying structure (Fig 405)

C The solid type which varies considerably in colour and appearance.

All tend to remain within an intact tunica albuginea and many show a flattened strip of testicular tissue spread over the surface of the growth. The spermatic cord becomes thickened owing to vascular hypertrophy but the vas is unchanged.

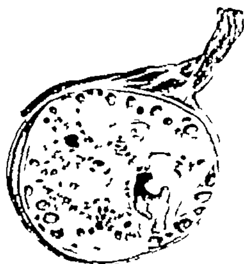


Fig 405

The typical polycystic or fibrocystic teratoma of the testis.

Sarcomata present an appearance similar to the fibroid in the uterus.

Microscopical Detail — Carcinomata are of two varieties. The Seminoma of Chevassu or the Spermatocytoma of other authors is a polygonal-celled carcinoma simplex with large cells resembling the more deeply placed ones of the seminiferous tubules The second type is the more embryonic papillary adenocarcinoma with smaller cells arranged in an alveolar formation showing papillary tufts.

Teratomata contain tissues representing the derivatives of all the three primary germinal layers Only rarely in testicular teratomata do fully formed adult structures occur The single cystic dermoid is extremely rare and in it hair teeth and skin are found but in the others the characteristic feature is the indiscriminate mixture of tissues without any attempt at regular arrangement Many show also carcinomatous and sarcomatous changes and about 125 cases of chorionic carcinoma are recorded These tumours are always potentially malignant and usually actively so apart from any such degeneration and metastases in the lungs and glands show the same admixture of cartilage nerve muscle and cysts as the primary growth Carcinomatous change is apt to destroy the original teratoma and if left long enough may predominate to such an extent that no trace of recognisable tissue is to be seen

Sarcoma is of the spindle or round-celled variety

Nature of these Tumours —Published results of the Aschheim Zondek reaction make it clear that this test is positive in a proportion of both seminomata and teratomata and negative in others These findings though inconclusive suggest that Ewing's theory that all

tumours of the testis are of primary embryonic nature may not be far removed from the truth

Symptoms.—Patients complain of a swelling of insidious onset possibly following a blow in the recent past There may be slight dragging pain along the cord Hæmatocele is not often seen unless the swelling has been explored by needling Involvement of the scrotal skin—"fungus testis"—can be seen *only in cases of neglect* The vas deferens is not affected but the cord is thickened from hypertrophy of the vessels. The lymph glands along the aorta and vena cava are involved early in the disease.

Diagnosis.—In early cases tuberculous epididymitis may be suggested and in others a gumma may prove misleading In over 50 per cent of tumours prolan is present in the urine and an Aschheim Zondek test will give a positive reaction to this extent therefore this test is of assistance *It must be clearly understood that a negative result does not exclude malignant disease*

Treatment.—The testis with the cord as far as the internal abdominal ring should be removed. The radical removal of the glands is a procedure which has little support in this country If enlarged glands are palpable the mass should be exposed through the loin and radon

	Epididymo-orchitis.		Tubercle.	Syphilis.	New Growth.
	Acute.	Chronic.			
Body	Affected.	Not affected.	Not affected.	Affected.	Affected.
Epididymis	Affected.	Affected.	Affected.	Not affected.	Not affected.
Tunica vaginalis (hydrocele)	Sometimes.	Occasionally	Rarely	Always.	Never
Skin	Red, œdematous, glazed.	Not affected.	Sinus.	Hernia testis (in late stages).	Rarely affected (*fungus testis*).
Vas deferens	Not affected early Thickened late	Thickened.	Thickened.	Not affected.	Not affected.
Spermatic cord	Some œdema.	Not affected.	Not affected.	Thickened.	Thickened.
Seminal vesicles	Affected later but not in early stage.	Affected.	Always affected sooner or later.	Not affected.	Not affected.
Prostate	Affected later but not in early stage	Affected.	Always affected sooner or later	Not affected.	Not affected.
Testicular sensation	Retained.	Retained.	Retained.	Lost early	Retained till quite late.
Testicular weight	Unchanged.	Unchanged.	Unchanged.	Much increased.	Increased.
Glands	Not affected.	Not affected.	Not affected.	Not affected	Early enlarged.
Other clinical signs	History of gonorrhœa. Cessation of discharge.	Previous history In rare cases, nothing	Evidence or history of tuberculosis elsewhere.	History and other stigmata of syphilis.	Nothing. Possibly history of injury

seeds implanted and in every case deep X-ray therapy of the lymphatic field should be carried out

The Prognosis is always grave these tumours being amongst the most malignant known. Recent statistics suggest a slightly more hopeful attitude to these neoplasms indeed a few examples appear to remain stationary and free from metastases for many months

Growths of the epididymis are exceedingly rare A few benign tumours are on record and carcinoma does occur

Diagnosis of Testicular Swellings—In the table on p. 843 the clinical features of the important testicular diseases are set out.

Careful attention to every clinical sign should give a correct diagnosis in a high percentage of cases Small nodules however may give rise to difficulty and in view of the terrible mortality of testicular new growths no expectant policy can be tolerated in doubtful swellings In the presence of small nodules in testis or epididymis and in the absence of any positive findings in the history symptoms or signs, the surgeon's duty is to look and see rather than to wait and see In this way only can the present high mortality of testicular growths be reduced.

THE TUNICA VAGINALIS AND SPERMATIC CORD

HYDROCELE

A hydrocele is a collection of fluid in the tunica vaginalis, in the persistent processus vaginalis or a cystic swelling in the testis, epididymis and cord They may be classified thus —

A Congenital (Fig 406).

1 Of the tunica vaginalis	Vaginal
2 Of the tunica and processus vaginalis	Congenital, Infantile, Hydrocele with an imperfectly descended testis
3 Of the processus alone	Encysted hydrocele of cord.
4 Of the testis 5 Of the epididymis	Spermatoceles
6 Dilatation of developmental remains	Hydatids of Morgagni, Organ of Giraldes, Vas aberrans of Haller

7 Diffuse hydrocele of the cord is a lymphangiectasis

B Acquired

8 Idiopathic
9 Traumatic
10 Infective { Acute / Chronic

Congenital Hydrocele

This is comparatively common (Fig 407) The condition may be bilateral and infants are brought for advice in the first three months. The congenital variety with the persistent processus vaginalis in free continuity with the peritoneal cavity may not become noticeable

until the child begins to walk It will then be seen at the end of the day and has disappeared by the morning This variety is likely to have a congenital hernia coexistent with it and the treatment is directed principally to that The vaginal and infantile varieties remain constant and have no hernia These should be tapped and injections of sodium morrhuate seem to give good results.

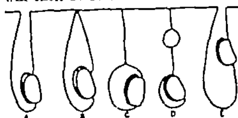


FIG 406

A diagram illustrating the varieties of congenital hydrocele.

A, Congenital; B, Infantile; C, Vaginal; D, Encysted hydrocele of the cord; and E, that associated with an imperfectly descended testis. The straight line at the top represents the peritoneum.

Encysted Hydrocele of the Cord.—This is due to the closure of the processus vaginalis both above and below the central part remaining patent The resulting cystic swelling does not necessarily become evident in infancy and may be seen in the second or third decade Its treatment is simple dissection from the cord.

Spermatoceles are cystic swellings in the epididymis and testis containing a whitish opalescent fluid in which will be found spermatozoa these may be alive or dead and in varying stages of development These cysts may be congenital in origin, occurring in children and young adults or acquired from fibrosis around the efferent ducts leading to a retention cyst or from rupture of the ducts leading to an extravasation cyst The majority occur in the globus major and form a well-defined spherical swelling attached to the upper pole of the testis, which latter is normal in shape and consistence Spermatoceles produce symptomless slowly enlarging swellings they are occasionally bilateral, in which case the patient may complain of impotence They are apt to cause atrophy of the testis after a long period and should therefore be excised. In elderly men whose sexual life has waned, tapping at regular intervals will suffice to keep them comfortable



FIG. 407

Bilateral congenital vaginal hydroceles in a boy of 16 years.

ACQUIRED HYDROCELE

This may be primary due to disease of the tunica vaginalis alone or secondary to disease of the testis epididymis or distant structures.

Acute Hydrocele as a primary condition is very rarely seen It is usually secondary to such testicular lesions as acute gonococcal epididymo-orchitis in which the hydrocele is apt to be overlooked owing to the severity of the testicular lesion The hydrocele subsides with the primary condition Rarely suppuration takes place and the tunica vaginalis will have to be opened and drained.

Chronic Hydrocele will result from the imperfect resolution of an acute attack or as a complication of chronic testicular disease It is present in many patients with syphilitic orchitis and occasionally in chronic tuberculous epididymitis The treatment is directed to the cause



FIG 408

An idiopathic acquired hydrocele showing the splaying out of the epididymis and the stretching of the digital fossa.

Idiopathic Hydrocele is the commonest variety of all. It occurs without apparent cause in men over 35 years of age The fluid is straw coloured and may be opalescent from the presence of cholesterin crystals. Its specific gravity is between 1022 and 1030 it contains 6 per cent of albumen and clots solidly on boiling but otherwise remains fluid indefinitely The tunica vaginalis is distended and thin (Fig 408) but fibrosis may occur especially after repeated tappings. The testis is rarely affected except in old long-standing cases when atrophy may result from pressure In very large hydroceles, especially when bilateral the penis may be withdrawn into the distended scrotal skin and its position marked only by a puckered dimple

Clinical Signs —In small hydroceles the testis is surrounded by a lax fluid swelling and is capable of exact definition In the large ones the tunica vaginalis may be so tensely distended that the testis cannot be identified (Fig 409) though pressure from behind may elicit testicular sensation However large it is its upper limit can be recognised and above it a normal spermatic cord identified passing on into the inguinal canal If a light is placed behind the scrotum a pink glow is transmitted through the hydrocele a dark shadow marking the position of the testis

The *differential diagnosis* rests between hydrocele inguinal hernia, hæmatocele spermatocele and solid enlargements of the testis and epididymis If the hernia is reducible no difficulty arises If irreducible its impulse on coughing absence of translucency and its prolongation into the inguinal canal should serve to distinguish the two conditions A hæmatocele corresponds in shape and position but is heavier less elastic and not translucent In other conditions the

definition of the testis and epididymis in relation to the swelling should serve to establish the diagnosis

Treatment — In nearly every case the hydrocele should be tapped when first seen in order to allow a complete examination of the testis and epididymis In secondary hydroceles tapping may be needed as a palliative measure while the exciting cause is being treated

In idiopathic hydroceles radical cure should always be advised except in old debilitated subjects Repeated tapping is not otherwise desirable. The technique of tapping demands a preliminary identification of the position of the testis by transillumination. The swelling is then grasped in the hand in such a way that the testis lies in the palm while the thumb and index finger grip the apex of the sac to steady it and prevent it sliding upwards towards the inguinal canal The thumb also holds the penis aside Pressure makes the skin taut and an area free of veins on the upper and outer surface is cleansed with surgical spirit. An exploring needle (No 10 or 12) mounted on a large syringe is passed into the sac in an upward direction and the fluid is aspirated until the sac is empty This method is preferable to the use of a trocar and cannula as being neater cleaner and less painful. The old methods of injecting tincture of iodine or carbolic acid cannot be too strongly condemned but injection with sodium morrhuate has a limited field of usefulness in small congenital hydroceles



FIG. 400

A large right-sided idiopathic hydrocele in a middle-aged man. The retraction of the penis is well shown.

The radical operation consists in exposing the testis by a short incision stretching from the external ring towards the scrotum The distended tunica vaginalis is made to present in the wound and is emptied by a trocar and cannula, after which the testis can be brought out of the scrotum The parietal layer of the tunica vaginalis is removed The cut edge will be underrun by a continuous interlocking stitch to prevent oozing Every bleeding point must be secured and a small drain brought out through a stab wound in the scrotum before the testis is replaced. These precautions must never be omitted as the occurrence of a scrotal haematoma is of grave significance owing to the danger of its becoming infected. The operation of incising the tunica vaginalis turning it inside out and fixing it around the cord is not to be recommended

Hæmatocele

This is a collection of blood in the tunica vaginalis. It is caused by injury either from direct blows *e.g.* kicks cricket balls etc or from surgical trauma in piercing a vein while tapping a hydrocele, or in exploratory puncture when a needle is thrust into a growth of the testis It does not occur as a complication of growth except after tapping or when the growth has penetrated the tunica albuginea and invaded the tunica vaginalis It is rarely seen in hæmophilia, leukæmia and scurvy The history of injury the shape and position of the non translucent swelling lead to a sure diagnosis In those cases without injury a blood count should be done and the testis examined for the presence of a growth

The *treatment* consists in rest in bed and firm strapping of the scrotum. It must not be tapped during the first forty-eight hours for fear of the bleeding recurring but this should always be done on the fourth day and the scrotum again firmly strapped. This routine tapping will save many patients a tedious convalescence If the swelling has not absorbed within a fortnight no further time must be lost and the tunica vaginalis should be opened and the clot removed. In later cases the radical cure for a hydrocele should be practised and in still later cases, with great thickening of the tunica and atrophy of the testis, an orchidectomy will be needed to relieve pain In non traumatic cases in the absence of any blood disease the testis should be exposed and searched for any sign of growth.

VARICOCELE

This is a varicose condition of the veins of the pampiniform plexus It is usually seen in the left spermatic cord of young men Various conditions are suggested as being contributory factors, none of which can be adequately supported. The left spermatic vein enters the left renal vein at a right angle and so the flow of blood in the spermatic vein is said to be impeded again the drag of a loaded sigmoid colon in habitually constipated youths is said to compress the vein at the pelvic brim It does occur though rarely as a result of malignant disease of the kidneys or other abdominal organs and a varicocele of insidious onset in elderly men should always lead to a searching abdominal investigation In the majority of cases no demonstrable cause exists

Symptoms are absent until the patient s attention is drawn to the condition by the exaggerated stories of friends as to its effects, or by his rejection as a candidate for the Services or big industrial concerns He will then complain of a sense of weight, aching pain and anxiety as to the future The appearance presented by the dilated veins is unmistakable and their feel has given the condition the name of a bag of worms

Treatment —It cannot be too strongly asserted that treatment is rarely necessary The profession is however forced into performing an unnecessary operation owing to the regulations of all the Services public bodies and big employers that varicocele is to be a cause for rejection of candidates on physical grounds In such cases the dilated

veins are injected with one of the sclerosing solutions used for varicose veins, *e.g.* quinine and urethrane or sodium morrhuate. A suspensory bandage can never be anything but a placebo and may do harm by centring a young man's attention on his external genital organs. Operative treatment consists in excision of a length of the varicose veins from the cord leaving two veins to carry on the circulation.

THE SCROTUM

The skin of the scrotum is liable to any of the skin diseases which occur elsewhere. Special mention needs to be made only of a few conditions.

INFECTIONS.—Acute infection is usually due to extravasation of urine (p. 829) or results from acute orchitis, or from an infected scrotal hæmatoma.

Chronic infection will follow the spread of a chronic process in the testis or epididymis, such as tuberculosis or syphilis, or be the result of sebaceous eczema.

Certain specific conditions, primary chancres, molluscum contagiosum and elephantiasis are not uncommon.

NEW GROWTHS.—Benign growths occur, such as sebaceous cysts and dermoids in the median raphe, and these need simple excision. Squamous-celled carcinoma of the skin appears to be almost entirely an occupational disease amongst chimney-sweeps, tar and paraffin workers. It may be preceded by an occupational dermatitis in which develops a scaly indurated patch that later breaks down into a typical squamous-celled ulcer. The glands in the groins will become affected but the growth is usually of low malignancy and of slow spread. Treatment is the excision of the affected area with the glands.

OPERATIONS ON THE TESTIS

Orchidectomy.—An incision 2 in. long is made over the external abdominal ring curving downward over the spermatic cord as it enters the scrotum. The subcutaneous fascia having been divided, an index finger is introduced into the scrotum and the testis separated from its loose attachments, until by traction upon the cord it can be made to prolapse into the wound. Somewhat firmer adhesions at the lower pole representing remains of the gubernaculum will need division, probably between artery forceps. The aponeurosis of the external oblique is now divided and the cord followed up to the internal ring. A crushing clamp is applied, the cord cut across and the stump ligated. The wound is sutured in layers, a small rubber drain being inserted through a stab in the base of the scrotum.

Should it be necessary to trace the vas further, it is separated from the cord which is clamped, ligatured and cut as before. The vas can now be followed downwards in the retroperitoneum and divided low down near its entrance into the seminal vesicle.

For Hydrocele.—Several procedures are described for the cure of hydrocele: the method here detailed is believed to be the best available.

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For Hydrocele.—Several procedures are described for the cure of hydrocele the method here detailed is believed to be the best available

The testis having been delivered into the wound as described above the tunica vaginalis is emptied by trocar and cannula and then opened. The redundant part of its parietal layer is removed leaving only a small margin (¼ in broad) around the line of attachment to the epididymis on either side. By this means the sac of the hydrocele is excised. A continuous haemostatic stitch is introduced along the cut edges and the testis replaced in the scrotum which is drained by a small rubber tube for thirty-six hours.

R. M. HANDFIELD-JONES

CHAPTER XXXIX

DISEASES OF THE FEMALE GENITAL ORGANS

THE purpose of this chapter is to draw attention to those gynæcological conditions which are commonly met with in general surgical practice and in particular to such as may give rise to difficulties in diagnosis Problems of purely gynæcological interest will therefore not be dealt with here As an example of an omission of this type neither vaginal prolapse nor uterine descent will be described in the following pages

Surgical Anatomy—The female genitalia comprise external and internal organs The external structures are the vulva with the orifices of the vagina and urethra and the glands and ducts of Bartholin, the whole being enclosed by the labia majora and minora The internal organs are the vagina cervix and body of the uterus, Fallopian tubes ovaries and certain vestigial remnants. These structures are supported and held in position by the levatores ani muscles, the broad and round ligaments, the ovarian ligaments and those condensations of cellular tissue in the base of the broad ligament known as the cardinal or transverse ligament of the cervix and the uterosacral ligaments

DISEASES OF THE EXTERNAL GENITALIA

VULVITIS

Vulvitis is an inflammatory condition of the vulva caused by injury uncleanliness or more commonly by infection with the gonococcus or other organism and associated with a discharge from the cervix or from the vagina. It is characterised by redness soreness difficulty and pain in walking and sitting and pain on micturition from an associated urethritis

Treatment consists in rest in bed, punctuated by sitting in hip baths of warm mildly alkaline or antiseptic solutions such as dilute dettol lotion for half an hour at a time If a cervical discharge is present and the parts are not too tender the vagina should be douched daily or more frequently After each treatment the vulva is dried and a mild ointment *e.g.*, zinc oxide and castor oil is applied With increased tolerance to manipulations local applications to the affected cervix can be commenced. If a Bartholin's abscess should supervene it must be incised and drained. Should gonorrhœal infection be suspected penicillin treatment should be started at once Alternatively sulphadiazine or a similar drug should be given in heavy dosage *e.g* 7 grm during the first twenty four hours and 1 grm four hourly day and night during the next three days. Every four hours also should be given a dose of an alkaline mixture containing about 20 gr of sodium citrate

and 20 gr of sodium bicarbonate Fluids should be taken copiously Neither this treatment nor penicillin appears to have any value in the treatment of vaginal infections by trichomonas vaginalis or by monilia

Certain special types of vulvitis may occasionally be seen though with the exception of diabetic vulvitis they are all rare *Gangrenous vulvitis* may occur in the puerperium and in association with severe venereal infection A similar condition is seen as a complication of the acute specific fevers, *e.g* measles, and to these types the term *Noma vulvæ* is applied (p 178) *Membranous vulvitis* occasionally occurs during diphtheria and is recognised by the greyish appearance of the membrane and by identification of the Klebs Loeffler bacillus In like manner *Typhoid vulvitis* may occur with or without ulceration in cases of enteric fever and other still rarer examples are the herpetic and the erysipelatous *Diabetic vulvitis* is caused by the irritating urine and frequently a superadded infection by monilia. It is quite commonly observed and often can be recognised by the raw ham colour of the vulval skin which may also exhibit excoriations and perhaps a scaly appearance Any case with some or all of these features must have the urine tested for sugar Should this be found the usual investigations and treatment must follow

LEUKOPLAKIA

Leukoplakia is essentially a disease of the *outside* of the vulva which causes itching (pruritus vulvæ) It is in the nature of a chronic inflammation and exhibits superficial proliferation of the skin of the labia majora and perineum so that areas of white thickening are present In the deeper layers there are hyperæmia and a round-celled infiltration with subsequent fibrosis Eventually shrinkage of this fibrous tissue leads to the appearance of fissures Leukoplakia is definitely a precancerous condition.

Treatment —Care must be taken to exclude any possible predisposing cause such as vulvitis or vaginitis When itching is troublesome in the early stages, calamine lotion may afford some relief and menthol ointment (1 per cent) is useful The more severe cases sometimes yield to X ray treatment though many authorities consider this dangerous and likely to increase the chances of malignant change Other patients are benefited by œstrin therapy (see below) though this also may well be considered a dangerous line of treatment for a precancerous lesion It is probably wise to advise that if the disease is of long-standing and resistant to treatment and certainly if fissures are present the affected area must be excised for fear of the development of carcinoma. A superficial excision extending only a slight depth into the subcutaneous tissues is sufficient unless there be any areas of possibly cancerous metaplasia

KRAUROSIS VULVÆ

Kraurosis Vulvæ is an atrophic condition of the superficial epithelium of the vestibule *i e* of the vulval skin within the labia minora It is thus to be contrasted with leukoplakia which affects the outside of the vulva and causes itching whereas kraurosis is a disease of the more

delicate and deeply placed skin and causes pain It must however be remembered that itching may also be one of the earliest symptoms of kraurosis Later when the thin vulval skin shows the classical white ironed-out appearance with tiny red spots where the more vascular dermis shows through pain on touching on micturition and during attempts at coitus becomes the predominant symptom

This condition is always due to ovarian deficiency either post menopausal or as the result of surgical or radiological castration It responds well to therapy by ovarian hormones or the synthetic œstrogens such as stilbœstrol (1 mg or less three times a day for ten days in each calendar month)

Relief of some of the symptoms of leukoplakia also occasionally follows treatment with the œstrogens But such treatment is possibly dangerous in view of the pre-cancerous nature of leukoplakia and the chemical similarity between the carcinogenic hydrocarbons and the œstrogens In short œstrogen therapy is frowned on in cases of leukoplakia but generally approved for kraurosis Despite this statement it must be admitted that it is still not clear that kraurosis and leukoplakia are really two separate conditions By some they are regarded as slightly varying responses to the same pathological process But it must be remembered that it is generally believed that it is only the latter which is liable to lead to carcinoma

INFECTIVE GRANULOMA

Papillomata occurring in the vulva are frequently due to gonorrhœa (p 63) or less commonly to uncleanliness Other patches of sodden thickened skin resembling papillomata may be found on closer examination to be sessile These are likely to be syphilitic condylomata. Numerous raised sodden patches of almost papillomatous skin *must* always be suspected of being syphilitic and they are certainly *very* heavily infected with spirochætes.

CYSTS

Cysts which occur on the labia majora may be due to *retention of* sebaceous secretion Bartholin's cysts are usually larger and are due to *occlusion of the duct* They appear first as elastic swellings in the posterior part of one or both labia *minora* but with increasing size they spread outwards into the labia majora *They should be excised* together with the remains of the gland which lies deep to them. The operation is not so simple as one would expect The dissection often has to extend quite deeply and several large blood vessels are divided It is unwise to attempt to excise a Bartholin s cyst except under general anæsthesia A rapidly developing swelling in this position which seems to be a cyst one day but is much bigger and more tender within twenty four hours is a Bartholin s abscess which should at once be incised and drained Such abscesses are of gonococcal origin in considerably less than 50 per cent of cases

Other types of cysts sometimes met with in the vulva will be found to contain tarry or chocolate-sauce fluid. They are now classified as

"endometriomata" and may sometimes be due to the implantation of functioning *i e* menstruating fragments of endometrium They should be excised.

GROWTHS

Innocent tumours, which are often pedunculated are found growing from the labia majora If causing inconvenience they should be excised when they will be found to be fibromata or lipomata

Carcinoma is usually squamous-celled but occasionally an adenocarcinoma arises in Bartholin s gland. The common type occurs on the labia or clitoris the patient being usually an old woman often in the region of 70 years of age *If the growth is primarily on one labium* a tumour may develop upon the other lip It has been customary to attribute this to implantation by contact but it is now thought that these contra lateral growths appear as the result of lymphatic spread. Rare cases of squamous-celled carcinoma arise from the region of the urethral orifice Leukoplakia is often a precursor of these growths which exhibit the typical appearance of such tumours, namely an ulcer with raised everted and indurated edges They are as a rule of rapid growth except in very old women frequently cause a great deal of pain in the vulva and spread to the inguinal glands is an early complication

It should be remembered that when a columnar celled tumour is excised from the vulva it may be a secondary implant from a similar neoplasm higher up in the genital tract *e.g* the body of the uterus

Symptoms are pain itching and a blood-stained discharge As a rule they do not appear until well after the menopause Examination may prove to be difficult as the growths are tender

Treatment has undergone a radical change in the last few years. It is now realised that radium and X rays are of little or no value also that excision of the vulva and inguinal glands gives only about 25 per cent five year cures Therefore the tendency is to be much more radical and the operation that is becoming widely adopted in this country is one of the most extensive in surgery It consists in a very wide removal of the vulva—so wide that no attempt to close the wound would be possible it is left open to granulate At the same time a strip of inguinal skin with the subjacent inguinal glands is removed the femoral vessels cleared of adventitia fat and the contained glands the inguinal ligaments divided and the dissection carried up extra peritoneally so as to remove on both sides the gland of Cloquet all the external iliac obturator and common iliac glands up to the aortic bifurcation in continuity with the glands in the femoral canal and the excised vulva It is worthy of note that vulvectomy wounds are now insufflated with sulphathiazole powder containing 1000 units of penicillin per gramme This has tremendously improved the healing of such wounds Inoperable growths are treated with radium needles, while in old women too fragile for radical treatment repeated local excisions may sometimes permit for years a life of reasonable comfort It is only fair to say however that there are times when a slow-growing tumour in the dried atrophic vulval tissues of an old woman is stirred into rapid growth by a local excision This is perhaps because of the increased vascularity which follows the trauma of the excision.

Sarcoma is a rare disease and when it does occur is more likely to be of the melanotic variety It is treated by wide excision plus irradiation which seems to be more beneficial for this condition than it is for a vulval carcinoma

DISEASES OF THE URETHRAL ORIFICE

Prolapse of the mucous membrane may occur either a mere pouting of the mucosa just inside the posterior margin or as a protrusion of the entire circumference The former must be distinguished from a caruncle and indeed is often referred to as a false caruncle Complete prolapse is painful both on sitting and walking and the mucosal cuff is liable to strangulation The prolapsed tissue should be completely excised the cut end of the urethra being sutured to skin margin

A caruncle is usually an infective granuloma but rarely is an adenoma arising in the urethral glands It presents a typical appearance of a miniature cockscomb growing from the posterior margin of the urethra immediately within the meatus. It is in almost half the cases, very tender causing pain on micturition and making walking and sitting uncomfortable It is highly vascular and blood may be seen on the clothing or appear in the urine

Treatment —The most satisfactory method is to excise or destroy by diathermy the caruncle and that area of skin from which it arises. This operation is not easy as the tissues are friable and difficult to handle Unless they are completely eradicated caruncles tend to recur and these recurrences should be examined histologically to exclude a possible malignant change

DYSFUNCTIONS OF THE FEMALE GENITAL ORGANS

These conditions are essentially of gynaecological interest but some description is necessary if only to convey certain warnings of real importance to the general surgeon

DYSMENORRHŒA

Premenstrual pain is always due to pelvic disease and its treatment is that of its cause Pain during the first twenty four hours of the period is a troublesome symptom which known as spasmodic or nulliparous dysmenorrhœa occurs in young women If it fails to respond to antispasmodic and analgesic drugs or to hormone therapy it may demand surgical treatment in the form of dilatation of the cervix and curettage of the uterus The former needs to be done thoroughly but slowly in order to avoid tearing the internal os Care must also be taken not to perforate the fundus uteri by a sudden slip of the dilator should this occur no harm will be done in a clean case provided all further manipulations are abandoned at once and no foolish attempt is made to explore the rent or disinfect the uterine cavity

Of recent years certain cases which have not benefited by any other form of treatment are being dealt with by presacral neurectomy This operation can only be recommended with caution for its results

are by no means always satisfactory It is true that only the worst cases are considered suitable and therefore the results achieved are among the least favourable patients Results show approximately a 50 per cent cure rate despite the claims of some enthusiasts this represents the true figure The question arises as to whether an abdominal operation of this sort is justifiable in a young woman for a condition which nearly always disappears when she reaches the age of 30 or as a result of marriage and childbirth

In other intractable cases the production of a temporary menopause by X rays or radium is sometimes suggested. This is a matter for the specialist and will not be considered here It should be regarded as a line of treatment which should only be adopted in desperate cases. Hysterectomy is mentioned only to condemn it as being entirely unjustifiable for dysmenorrhœa.

Pain at the period times which commences in the middle thirties in a woman who has previously been free from menstrual pain is suggestive of endometriosis If bilateral adnexal swellings are palpable or if a wedge similar to that felt in cases of peritoneal carcinomatosis can be palpated in the pouch of Douglas, then the diagnosis is highly probable All cases of pelvic endometriosis should be dealt with by an expert gynæcologist

STERILITY

Certain minor gynæcological abnormalities (*e.g* retroversion, pinhole os) are worthy of treatment in any woman complaining of sterility but if the patient is apparently normal no operative treatment should be considered until her husband has had a detailed examination made of a fresh seminal specimen which is produced after at least one week s abstinence from intercourse The details of the test should be arranged by one who is repeatedly doing such examinations and only the opinion of such an expert as to the degree of fertility of any specimen is of value The mere recognition of active motile spermatozoa in a specimen in itself carries little weight as a criterion of fertility Sixty million sperms per cubic centimetre of semen is usually regarded as the minimum for fertility and the number of deformed heads and non motile sperms must not exceed 20 per cent of the total.

MENORRHAGIA

Menorrhagia—excessive or too frequent menstruation—may be due to —

1 Pelvic Disease Fibroids salpingitis or displacements

2 Endocrine Dysfunction —This is not uncommon at puberty and responds to daily intramuscular injections of 5 to 25 mg of progesterone Other women may menstruate normally until between 30 and 40 years of age and then have increasing monthly loss. This is no longer regarded as consequent upon endometritis but as due to some hormonal imbalance In most cases no attempt at a more definite pathological explanation is made Others are labelled metropathia hæmorrhagica if both clinical and histological findings conform to a

certain pattern These patients may be relieved by injections of progesterone or testosterone or by curettage Others respond well to huge doses of the synthetic œstrogens *e.g* stilbœstrol 10 to 20 mg thrice daily for a few days only Some intractable cases however demand hysterectomy The production of an artificial menopause by X rays or radium at this age is quite indefensible

Yet other cases of menorrhagia do not appear until the time of the menopause this used to be attributed to metritis or fibrosis uteri The fibrosis is now recognised as the normal condition for parous women at this age and the disturbance is now regarded as being due not to a pathological change in the uterus but to endocrine upset Diagnostic curettage to exclude carcinoma of the uterus followed by the production of an artificial menopause by X ray or radium is the usual treatment for severe cases and is safely permitted in women of 45 years of age or more Alternatively hysterectomy may be performed and in cases associated with prolapse vaginal hysterectomy combined with a plastic repair operation is clearly the complete treatment

INFECTIONS OF THE FALLOPIAN TUBES AND OVARIES

These structures are conveniently described together since involvement of one leads to a spread of infection to the other and also to the opposite tube and ovary to a greater or lesser degree Approximately 80 per cent of such cases are due to gonococci or one of the pyogenic cocci the remaining 20 per cent being caused by the tubercle bacillus pneumococcus or *B coli*

ACUTE SALPINGITIS

Acute Salpingitis (acute salpingo-oöphoritis) occurs in young women who have had a recent miscarriage or an attack of gonorrhœa Such cases appear clinically as a localised pelvic peritonitis with low abdominal pain and an attack of vomiting which may precede the onset of the pain. The lower abdomen is tender especially just above the inner half of each inguinal ligament and above the pubes Lower abdominal rigidity appears later Temperature tends to be somewhat higher than that seen in acute appendicitis On vaginal examination there is marked tenderness postero-lateral to the cervix on both sides a discharge is evident and some uterine bleeding may be demonstrated by the presence of blood upon the examining finger The tenderness is apt to prevent the recognition of a palpable swelling in the pelvis and indeed such a lump may not be felt during the first day or two of the acute attack.

Differential Diagnosis from acute appendicitis is the chief difficulty The points to be noted are (1) the history of a recent abortion or discharge (2) position of the tenderness which is either bilateral or medial both on abdominal and vaginal examination (3) vomiting is usually marked (4) the uterine bleeding and rather high temperature

and (5) a purulent or muco purulent discharge Urinary infections must be borne in mind and will be distinguished by frequency of micturition and the presence of pus and organisms in the urine Twisted ovarian cysts and ectopic gestation are not so suggestive of an acute inflammatory condition.

Treatment --If the diagnosis is certain the treatment is palliative—heat to the abdomen by hot water bottles or an electric pad, morphia to relieve pain and to restrain intestinal peristalsis and the administration of one of the sulphonamide group of drugs in dosage as suggested early in this chapter or better by systemic treatment with penicillin. The intramuscular injection of 300 000 units of procaine penicillin morning and evening for the next four or five days should suffice As the acute phase passes off absorption of the residual pelvic mass may be assisted by the use of hot vaginal douches and short wave therapy If acute appendicitis cannot be excluded a laparotomy must be done Should the condition prove to be tubal and the inflammation not too severe it is wise to close the abdomen without drainage The damage would need to be very extensive with tubal destruction nearly to the stage of gangrene before both tubes should be removed ablation of the more seriously infected one alone is futile since the other must become involved. Most of these cases clear up reasonably well particularly with the newer methods of treatment though occasionally cases may lead to dense adhesions in the pelvis and to chronic invalidism, possibly calling for more drastic treatment at a later date

SUBACUTE AND CHRONIC SALPINGO-OOPHORITIS

These may follow an unresolved acute attack or occur primarily as a mild infection or as infection with the tubercle bacillus Recurrent attacks of pain usually premenstrual and pyrexia punctuate a chronic illness of varying severity which is characterised by backache or other pelvic pain and by menorrhagia and discharge A vaginal examination reveals inflammatory swellings behind and to one or both sides of the cervix The uterus itself will be fixed

The differential diagnosis is from pelvic endometriosis (in which the pain is usually menstrual rather than pre menstrual and is made worse instead of improved by ultra-short wave diathermy) and from the milder and less dramatic cases of ectopic gestation In these cases the pelvic ma s should be unilateral

Prolonged palliative treatment must always be given a trial and short wave therapy is most valuable in this connection I the trouble persists and is incapacitating or if recurrent attacks are frequent and disabling surgical treatment is required Its guiding principle must be to remove both tubes and to conserve some healthy ovarian tissue if possible

Cases of chronic salpingitis in virgins or women with a tuberculous hi tory may be found to exhibit a **tuberculous pyosalpinx** of one or both tubes (Fig 410) It is probably wise to treat a case su pected of being tuberculous salpingitis by sanatorium treatment or even by small repeated doses of deep X rays rather than by surgery Streptomycin has recently given some encouraging results but the

practical difficulty is that the diagnosis can only be made with certainty at laparotomy. And if the abdomen is open many surgeons find it difficult to resist the temptation to remove the affected tubes. This however would probably be useless as the ovaries and uterus are also likely to be diseased. And if ill fortune should result intractable fistulæ may follow any extensive surgical procedure. Generally speaking therefore attempts at excising tuberculous adnexal disease are to be deprecated.

One other complication of inflammation is a pelvic abscess. This causes downward bulging of the posterior fornix and an intermittent pyrexia. Such an abscess may burst into the rectum or can be opened and drained through the posterior fornix.



Fig. 410

Bilateral tuberculous pyosalpinx.

PARAMETRITIS

Pelvic Cellulitis occasionally complicates salpingitis but more commonly is seen as a post-operative complication or during the second week of the puerperium. It causes pelvic pain, pyrexia and a mass which pushes the uterus towards the opposite side. Under palliative treatment it usually resolves but may result in an abscess which points just above the inguinal ligament. Rarely it comes to the surface in Scarpa's triangle, the buttock or ischiorectal fossa. The treatment is by local application of heat and by penicillin or one of the sulphonamides.

EXTRA-UTERINE GESTATION

Though ovarian pregnancy is known, the majority of ectopic gestations are *tubal*. The common sequence of events is: (1) a mild tubal infection, (2) occlusion of the tubes for a time, (3) a period of *sterility*, (4) spontaneous reopening of the tube, (5) ascent through this *opening* of sperms and fertilisation of an ovum, (6) the failure of this latter to find its way into the uterus, and (7) its impaction in a cul-de-sac *of the tube*.

The growing ovum embedded in the tube is bound, sooner or later, by its trophoblastic erosive action to open into a blood vessel, *the* resulting hæmorrhage leading to death of the ovum and then continuing either through a hole *torn in the side* of the tube or along the lumen of the tube and out through the abdominal ostium. The severity of the subsequent *symptoms is* proportionate to the amount of intra-abdominal hæmorrhage.

Symptoms—An ectopic pregnancy may be diagnosed occasionally before rupture by the discovery of a pulsatile swelling in the position of one tube in a woman with symptoms of pregnancy This however is very unlikely and for all practical purposes it may be accepted that no ectopic gestation is diagnosed until some symptoms have been produced These can be described in two groups.

A. *Symptoms of Tubal Rupture.*—The history of one missed period is present in the majority of patients although the erosion of a blood vessel may take place so early that the time for the next period has not arrived. The clinical picture is that of severe internal hæmorrhage It is heralded by a sudden acute abdominal pain which may be precipitated by straining at stool or other effort The patient may faint It is usual for there to be slight external bleeding following the onset of pain and the patient may assume that the expected period has started Examination shows all the signs of internal hæmorrhage with some tenderness in the lower abdomen Blood will be found on the finger examining per vaginam slight uterine enlargement may be detected and tenderness in the fornices is well marked. One of the most suggestive diagnostic points is this extreme tenderness. A palpable fullness in the pouch of Douglas indicates the presence of clotting blood and pulsation may sometimes be felt

B *Symptoms of Slight Tubal Bleeding*—Not all ectopic gestations end in the above dramatic manner Others cause a slight hæmorrhage which kills the ovum and allows a slight trickle of blood into the pelvic peritoneum This collects around the tube and clots to form a palpable mass known as a "hæmatocele Clinically some cases present them selves as milder editions of the acute ruptures but others are difficult to diagnose although the history is highly suggestive in a young woman with continuous or intermittent uterine bleeding and periodic attacks of pain. If a period has been missed and a mass can be felt on one or other side of the pelvis the diagnosis is clear But there is often the greatest difficulty in distinguishing one of these cases from a subacute salpingitis which happens to be more evident on one side of the pelvis only or from a case of pelvic endometriosis.

Treatment—The ruptured gestation with severe internal bleeding demands immediate laparotomy and removal of the affected tube A transfusion of blood will be needed in many cases but despite the apparent gravity of this condition the prognosis is good In the other group of cases laparotomy is again required and it may be possible to incise the tube remove the mole and repair the tube But in most patients the tube must be taken away

TUMOURS OF THE OVARY AND BROAD LIGAMENT

OVARIAN CYSTIC TUMOURS

The Multilocular Pseudomucinous Cystadenoma is the commonest ovarian cyst forming about 80 per cent of the total number (Fig 411) When small it sometimes gives rise to pain and may be recognised as a spherical elastic tumour to one side of and posterior to the uterus

(bilateral masses would suggest inflammatory disease) More usually these cysts give rise to no symptoms till they are large enough to cause abdominal distension (Fig 412) They are then to be distinguished from pregnancy by the absence of any menstrual changes of audible fœtal heart sounds or of palpable fœtal parts from fibroids by their more elastic consistence from ascites because the cysts are dull to percussion while the flanks are resonant and from a distended bladder by the passage of a catheter



Fig 411
A multilocular pseudomucinous cyst.

Treatment consists in removal care being taken to avoid tapping or rupturing the cyst and to ligate securely the very large vessels in the pedicle Cystectomy the enucleation of the cyst while still retaining some normal ovarian tissue in the neighbourhood of the hilum is sometimes possible

The Serous Papillary Cystadenoma will come under the notice of the general surgeon either as a swelling noticed during a rectal examination in a case of ascites or at an exploratory laparotomy in such patients The condition present comprises bilateral masses in the pelvis postero-lateral to and adherent to the uterus These tumours will be partly cystic and partly solid with masses of papillary intracystic growths Histologically they cover a wide range some being innocent and others being active papillary carcinomata while between these limits there exists a group of cases which appear malignant and have secondary peritoneal deposits but in which removal of the primary tumours may be followed by the disappearance of the secondaries



Fig. 412
An elderly patient showing the great abdominal distension due to very large ovarian cyst.

Owing to this difficulty in recognition of the type of growth these tumours should be removed whenever they can be freed without undue bleeding At the same

time it is desirable also to perform total hysterectomy Even the most hopeless-looking cases may yield unexpectedly good results. But the reverse is unhappily more common An apparently innocent ovarian cyst is removed and the appearance of malignant deposits within a year comes as an unpleasant surprise This points to the necessity for a careful histological examination of every ovarian cyst after its removal.

Ovarian Dermoid Cysts are teratomata They occur at all ages, are sometimes bilateral grow slowly and rarely exceed 4 in. in diameter The elements which tend to predominate in these tumours are those derived from epiblast and many are filled with hair and sebaceous material (Figs 413 and 414) They are discovered in the



FIG. 413

A typical example of an ovarian dermoid cyst showing teeth and hair



FIG. 414

An ovarian dermoid cyst containing teeth embedded in its wall which has developed a massive squamous-celled carcinoma.

pelvis during a vaginal examination for such symptoms as pain frequency or retention of urine

Treatment consists in removal of the whole tumour on the grounds that malignant change sometimes occurs Most gynæcologists would, however perform cystectomy retaining the normal ovarian tissue which can nearly always be found and isolated in cases of ovarian tumours recognised as being dermoid cysts

Endometrioma or tarry cyst of the ovary is believed to be due either to metaplastic changes or to fragments of endometrium which succeed in implanting themselves upon the ovary These fragments are then supposed to burrow deeper and, by taking part in the process of menstruation to distend the ovary into a cyst containing blood which comes to look like liquid tar or chocolate sauce They occur in women about 30 to 40 years of age and their presence is suggested by menorrhagia and dysmenorrhœa the periods having previously been painless

A vaginal examination reveals bilateral masses postero-lateral to the uterus These are probably diagnosed as salpingo-oöphoritis and their true nature is recognised only at operation when great

difficulty is encountered in separating the adhesions. The realisation that the pain is menstrual in time rather than pre-menstrual in some cases points to the correct realisation of the condition. The diagnosis is clinched at operation by the flow of typical fluid when the cyst bursts. They should be removed but any healthy ovarian tissue should be conserved if possible.

Broad Ligament Cysts.—Small cysts about the size of a cherry arise in the mesosalpinx from remnants of the Wolffian duct and are of no clinical significance.

Large cysts called **fimbrial cysts,** which may grow to many inches in diameter (Fig. 415), originate in a similar position between the layers of the broad ligament. These are unilocular and have the tube, the ovarian fimbria, the ovary and ovarian ligament spread out over one part of the cyst in the form of an oval ring. They are usually misdiagnosed as ovarian cysts and should be removed by shelling them out of their cavity in the broad ligament.



FIG. 415
A large fimbrial cyst.

SOLID OVARIAN TUMOURS

Fibroma is usually mistaken for a uterine fibroid, but it is often accompanied by ascites and is freely movable apart from the uterus. It should be removed.

Carcinoma.—Primary carcinoma may be a solid tumour or may be papillary and cystic. It is usually bilateral and is discovered on rectal or vaginal examination in a case of ascites. Secondary carcinoma usually follows a primary growth in the breast, the colon or the stomach. It may be discovered as a bilateral mass in the pelvis accompanied by a typical wedge-shaped growth developing from fragments which have fallen to the bottom of the pouch of Douglas, the process known as Transcoelomic Implantation (see p. 88). When such secondary deposits are found it is clearly useless to attempt to remove the more obvious ovarian tumours. A special variety of ovarian carcinoma secondary to a gastric neoplasm is described and is seen microscopically to contain curious "signet ring" cells. This type of ovarian new growth is known as the "Kruckenberg Tumour." Such a growth may be found at examination and removed before any symptoms have drawn attention to the primary gastric condition. The recognition of the nature of the growth subsequent to its removal will indicate the very high probability that a leather bottle stomach is present.

Dysgerminoma.—This and other rare solid ovarian neoplasms, some of which have hormonal activity, need not be considered here. If they are discovered by a general surgeon they will be removed as a "lump" and the curious nature of the tumour only discovered if it is examined by an experienced pathologist.

2 **Placental Polypi** consist of remnants of placenta covered by blood clot and fibrin. They give rise to continued bleeding after childbirth or miscarriage and should be removed by curettage

3 **Fibroid Polypi** are submucous fibroids which have gained a pedicle by projecting into the lumen of the uterus They cause metrorrhagia. The hæmorrhage may be so severe that a profound degree of anæmia results Their presence may be diagnosed by continued bleeding from a uterus which is obviously enlarged by one or more fibroids. Alternatively one may be discovered as a hard, rounded mass presenting through the cervix If they have descended into the vagina and have become infected and necrotic they may be friable and possibly mistaken for a cervical carcinoma. They should be removed and the uterine cavity explored with a finger sponge holder or curette to exclude the presence of a second smaller fibroid polyp

CARCINOMA OF THE UTERINE BODY

This growth usually occurs in women well past the menopause who have borne few or no children. It causes irregular bleeding, sometimes accompanied by pain due to uterine contractions All cases of post menopausal bleeding must be suspected of malignancy and curetted so that the diagnosis may rest upon an histological basis

Treatment consists in a panhysterectomy together with removal of both tubes and ovaries. Results of this operation show a 60 per cent cure and surgery should be advised in preference to radiation But there is an increasing tendency to follow operation by deep X ray therapy

CARCINOMA OF THE CERVIX

This occurs at an earlier age, often between 45 and 50 years, in women who have borne children. It is predisposed to by injury and infection of the cervix and gives rise to irregular bleeding which shortly changes to a watery blood-stained discharge which later becomes offensive It is unfortunate that women at this age regard irregular bleeding as a more or less natural phenomenon and, by neglecting to seek advice allow the growth to become advanced before they are examined.

On examination the cervix bleeds easily and a rough friable area is felt A useful test is to press the point of a sound against such a spot. If the point penetrates easily the diagnosis of carcinoma is established. In every case of doubt a piece of suspected tissue must be removed for microscopy

Treatment—In early cases in women under 65 years of age who are not too fat Wertheim s extended abdominal hysterectomy is still considered the method of choice by a few gynæcologists But the general trend of opinion is to regard treatment by radium locally following the Stockholm or Paris techniques) and iliac lymphadenectomy or deep X ray therapy to the gland areas as preferable

Differential Diagnosis—Erosion of the cervix is an inflammatory process in that part of the cervix around the external os which results

in this part of the vaginal portion of the cervix becoming covered with columnar and not squamous epithelium This columnar type of epithelium bleeds easily when touched and as it is secreting actively produces an excess of discharge which appears per vaginam On inspection by the inexperienced the appearance may be confused with carcinoma but it may easily be distinguished by the absence of friability when tested with the sound. This condition is treated by diathermy or the actual cautery

Ectropion of the Cervix results from the splitting of the cervix during labour into an anterior and a posterior lip These lips then become covered with columnar epithelium The cervix is seen as a red gaping structure which bleeds easily and produces a profuse discharge Cervical ectropion may be associated with the symptom of



FIG. 417

A hydatidiform mole after being passed from the uterus.



FIG 418

A hydatidiform mole in situ. At the right-hand lower corner a chorionic carcinoma has developed.

low backache The *sound test for* friability serves to distinguish it from carcinoma

Treatment is operative reconstruction of the normal shape of the cervix

SARCOMA

Sarcoma of the uterus is rare and occurs in the body rather than the cervix In the former it is seen as a diffuse growth causing bleeding and uterine enlargement It shows a marked clinical resemblance to fibroids but the rate of growth is more rapid.

Treatment is panhysterectomy with bilateral salpingo-oöphorectomy

Prognosis is bad. Few cases of definite uterine sarcoma live for more than twelve months after the diagnosis is made

CHORIONIC CARCINOMA

This rare and fatal disease occasionally occurs in the tubes after an ectopic gestation but is more often found in the uterus It is apt to follow a hydatidiform mole (Figs. 417 and 418) or much more rarely a normal pregnancy Such cases are suggested by continued bleeding after the passage of a hydatidiform mole It is probably unwise to explore the uterus with a curette in these patients since this may serve to disseminate the tumour It is safer to rely upon the Aschheim Zondek reaction which will be found to be positive when the tested urine is diluted 100 or even 200 times if it comes from a patient with either a hydatidiform mole or a chorionic carcinoma. If a hydatidiform mole is diagnosed by this test together with the clinical findings and if the mole is then passed spontaneously or removed by operation the test should give a weakly positive result or even become negative within a month a return of uterine bleeding together with again a strongly positive test provides a sufficient basis for a diagnosis of chorionic carcinoma Under such conditions panhysterectomy plus bilateral salpingo-oophorectomy must be performed, but the prognosis is poor These growths are radio-sensitive so that radium and deep X ray therapy may help to improve the results.

LESLIE WILLIAMS.

CHAPTER XL

DISEASES OF THE SCALP AND SKULL

THE SURGERY OF THE SCALP

SURGICAL ANATOMY.—The soft tissues covering the vault of the skull have a highly specialised structure. The skin is thick and profusely supplied with hair follicles, while the *subcutaneous tissue* comprises a thin fibrous layer containing lobules of coarse fat. Underlying this is the *occipito-frontalis* (or epicranial) *aponeurosis* a broad sheet of fibrous tissue acting as an intermediate tendon between the occipitalis muscle behind and the frontalis in front These three strata of the scalp are so closely attached to each other that they enjoy a limited range of movement together through the action of the occipito-frontalis muscle Beneath the epicranial aponeurosis is a space filled with loose areolar tissue, lying directly upon the *pericranium* (*i.e.*, periosteum of the skull) It is this space which permits the movements of the scalp The epicranial aponeurosis fuses laterally with the fascia covering the temporal muscle while the occipito-frontalis is attached in front to the superciliary ridges and behind to the superior curved line of the occipital bone These relations are of great surgical importance in that effusions of blood or pus beneath the aponeurosis can spread widely in all directions.

The *blood supply* of the scalp is derived from the supra-orbital branch of the internal carotid artery in front and from the superficial temporal, posterior auricular and occipital branches of the external carotid behind and laterally There is a free anastomosis between the two sides. The scalp is particularly richly supplied with vessels which run in the fibrous subcutaneous tissue to this their outer coats are attached so that they cannot retract when incised or lacerated. It is for this reason that wounds of the scalp bleed so profusely The *venous return* also is free and presents one anatomical relation which has a surgical significance of the highest import, viz., the intercommunication between the veins of the scalp and the great venous sinuses of the interior of the skull by means of "emissary veins." These are found in the temporal and occipital regions (with the lateral sinus) in the parietal and nasal areas (with the superior longitudinal sinus) and at the inner angle of the orbit, where the angular vein effects a communication with the cavernous sinus.

The *lymphatics* run to the pre-auricular occipital and posterior cervical glands consequently infective lesions of the scalp will usually cause enlargement of the glands in the posterior triangle of the neck.

The *nerve supply* is from the auriculo-temporal, supratrochlear and supra-orbital branches of the Vth cranial nerve and from the great and small occipital nerves derived from the first and second cervical.

The *pericranium* has a loose attachment to the bones of the skull, except at the sutures where it is closely adherent Inflammatory and hæmorrhagic effusions beneath this membrane therefore can spread only to the extent of the bone concerned.

INJURIES OF THE SCALP

Hæmatoma of the scalp is caused by blows of moderate violence either by blunt instruments or as the result of a fall. It is seen in the heads of newborn babies after a prolonged or difficult labour with or without forceps Three types are described

1 SUPERFICIAL BRUISES are confined to the fibrous subcutaneous tissue and are therefore small and circumscribed

2 SUBAPONEUROTIC i e. beneath the epicranial aponeurosis are often a result of fracture of the vault of the skull. The extravasation is limited only by the attachments of the occipito-frontalis and, if the bleeding is severe the scalp appears to be floating on a fluctuating cushion, which may pulsate when a large artery has been torn. The swelling tends to collect at the dependent margins i e. the eyebrow temporal and occipital regions. In many cases however the effusion remains localised to the zone of trauma.

3 SUBPERICRANIAL collections are uncommon The effusion is confined to the extent of the bone involved by the firm attachment of the pericranium to the sutures They are seen as a result of injury either at birth or at a later age. These cephalhæmatomata appear as soft fluctuating swellings which rapidly achieve a raised and indurated surrounding wall of blood clot and fibrin. The clinical signs are sufficiently misleading to suggest to the inexperienced a depressed fracture The two conditions should in reality easily be differentiated, for the edge of a hæmatoma is raised above the level of the bone and can be made to pit on firm pressure

Treatment of all hæmatomata of the scalp consists in rest in bed and the application of cooling lotions to the head. It must be remembered that their importance lies in the likelihood of their being associated with far more serious injury to the underlying bone and brain.

Wounds are of great frequency and it is fortunate that the scalp with its generous blood supply possesses remarkable powers of healing These wounds tend to be triangular in shape a flap often being torn down from the skull and, even although the pedicle is quite narrow the blood supply will be sufficient to prevent sloughing If the wound is superficial to the aponeurosis the edges do not gape and little damage is likely but if this is divided the margins retract and there is great danger of sepsis being implanted in the loose areolar tissue in which it may spread far and wide

Treatment.—Before suturing the wound the hair around it must be shaved and its depth examined for the presence of bone injury or foreign body It is then thoroughly cleansed with C T.A.B lotion and dusted with penicillin (1000 units) and sulphathiazole powder (1 grm) Chemotherapy is now so effective that scalp wounds should be closely and accurately sutured as for surgical wounds. The epicranial aponeurosis is first sewn with fine sutures of waxed or plastic impregnated silk and the scalp closed with similar material. The stitches are cut in forty-eight hours and removed the following day During these days systemic penicillin is administered by a daily injection of 500 000 units of procaine penicillin

Avulsion of the Scalp is produced in women workers by their hair being caught in machinery The tear occurs above the ears and eyebrows and the scalp is pulled backwards

Treatment consists in thorough cleansing of the area followed by repair If the scalp has been completely severed it should be secured and if it is unmangled it is worth suturing it in position as a full thickness graft Even if only a small part survives it assists in the subsequent healing Large raw areas can be rendered less conspicuous by the method shown in Fig 419 An incision is made on each side and the two strips are slid inwards and sutured together All uncovered areas will be generously dusted with penicillin powder and covered with Thiersch skin grafts forthwith

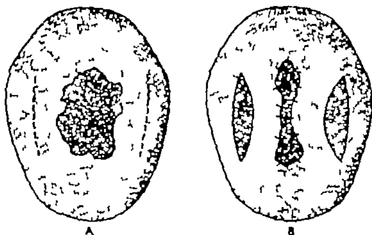


FIG. 419

A shows the incisions made on either side of the central raw area ; B illustrates the decrease in size of the latter

Burns of the Scalp are of three types (1) Mild superficial burns from hair waving machines do not cause much pain, but lying concealed under the hair are liable to become septic (2) More severe burns result from accidents with celluloid combs They leave intractable ulcers, which lead to difficulties in treatment (3) Deep burns sometimes follow epileptic seizures or alcoholic stupor as a result of the patient falling and resting his head either in the fire or on the hot bars The bone may be destroyed and *septic intracranial complications follow*

DISEASES OF THE SCALP

Sepsis in the Scalp arises in the spread of infection either from the surface or from the bones of the skull. As in the description of hæmatomata so in this case three types of abscess are defined

1 SUBCUTANEOUS ABSCESSES are small and circumscribed usually following surface infections such as eczema, impetigo pediculosis or boils in young patients

Treatment is incision.

2 SUBAPONEUROTIC INFECTION is serious owing to the absence of any barrier to its spread over the whole vault Pus may point at one or more places around the periphery of the epicranial aponeurosis This type of sepsis is especially common to-day in association with motor accidents

Treatment consists in one or more incisions at the margin of the swelling combined with intensive chemotherapy

3 SUBPERICRANIAL ABSCESS must always be a grave lesion. It is due either to disease of the bone or to tracking of pus through the skull from intracranial suppuration. Early incision and drainage is called for

Cellulitis and Erysipelas are common complications of scalp wounds They have the same appearance here as in other parts of the body Their treatment has been greatly simplified since the introduction of the sulphonamides and penicillin (p 207)



FIG. 420
Cock's peculiar tumour

Cysts of the Scalp —SEBACEOUS CYSTS (Epidermoids or Wens) are very common and are frequently multiple They have been described on p 240 They rarely become malignant, giving rise to a Cock s peculiar tumour (Fig 420) *Treatment* is excision under local anaesthesia

DERMOID CYSTS occur only in the neighbourhood of the anterior and posterior fontanelles and in the temporal area. They are described in general on p 114 and those on the face on p 314 They are not attached to the skin but have a fibrous pedicle to the underlying bone

Treatment —The cyst should be removed but it is preferable to postpone operation until after puberty when any possible communica tion with the meninges will have been closed

Vascular Swellings.—Nævi and aneurysms of all types occur in the scalp as elsewhere

CIRSOID ANEURYSM (p 204) is rarely seen except in the scalp and face commencing usually in the temporal region, whence it may spread over the whole head and downwards to the face and ear Large tortuous *pulsating vessels are seen, and the patient complains of rushing and* roaring noises giddiness and headaches These aneurysms develop from angiomata generally of the "port wine stain type

Treatment is not very satisfactory but a recent two-stage operation marks an advance A flap of scalp including the aneurysm is turned slowly down and all the open vessels at the edge coagulated by diathermy The flap is replaced with a pack of rubber tissue between it and the bone Ten days later it is again reflected, when the vessels will be found to have thrombosed and can be dissected out External carotid ligature on one or both sides may help and radium or X rays are sometimes of value in controlling angiomatous outgrowths in inaccessible areas (*e.g* the orbit)

TEMPORAL ARTERITIS is an acute inflammatory disease and sometimes when affecting the occipital arteries as well can result in sloughing of the scalp Excision of a length of the artery immediately relieves the severe pain and the microscopical examination reveals the giant cells which characterise this special form of arteritis

New Growths.—ADENOMATA of both sebaceous and sweat glands are rarely seen in the scalp and a still more uncommon tumour is *the adenoma adenoides cysticum* (p 240)

PAPILLOMATA in the form of small warts are common but give little inconvenience LIPOMATA often arising from the pericranium appear as flattened circular swellings. NEUROFIBROMATA are occasionally met with in the scalp usually in the distribution of the supra-orbital nerve When large they become pedunculated being then known as PACHYDERMATOCELES All these tumours should be removed if causing symptoms or disfigurement

A SQUAMOUS-CELLED CARCINOMA is far less common in the scalp than on the face but sometimes arises in a wart scar or sebaceous cyst or area previously treated by X rays It must be removed and the raw area covered if necessary by skin grafting

SARCOMA rarely occurs except as the result of invasion from the underlying bone or in the form of secondary deposits.

Cephalhæmatocele (sinus pericranii) is an exceedingly rare swelling consisting in a collection of venous spaces which communicate with the superior longitudinal sinus through a gap in the suture It appears as a soft tumour in the midline over the vertex and has an impulse on coughing and is reducible It must be excised and the communicating channel ligated.

THE SURGERY OF THE SKULL

Head injuries form a large proportion of the emergency admissions to hospital at the present time It is of the greatest importance that at the outset students should appreciate the relative significance of fractures of the skull. Intrinsically an uncomplicated fracture of any part of the cranium is of little import and requires no treatment beyond rest in bed The force however capable of fracturing the skull, must be such that the intracranial contents are hardly likely to escape injury Attention, therefore must be directed more critically to the signs and symptoms of damage to both brain and cranial nerves rather than to the diagnosis of fracture An inexperienced resident so frequently regards an X-ray as an urgent necessity in a patient who obviously has a severe contusion or laceration of the brain. Certain complications are more often associated with fractures of different parts of the skull consequently it is customary to describe the latter under separate headings

A contusion of the skull is usually accompanied by injury to the overlying soft parts A hæmatoma may collect beneath the pericranium and will have no serious effects provided that it does not become infected. Should this occur osteomyelitis may follow with grave possibilities such as subdural or intradural abscess

FRACTURE OF THE CRANIAL VAULT

Fissured Fractures

A fissured fracture as its name implies, is a crack in the skull usually of the vertex, without displacement It may consist in one fissure or may assume a star shape with radiating cracks passing in several directions. The length of any one fracture varies greatly in some cases it may pass downwards until it involves the base of the skull Care must be taken that the normal sutures and vascular channels are not mistaken for fracture lines. This type of injury is the result of a fall or blow from a blunt instrument It may be closed or compound but in every case a considerable degree of bruising of the soft tissues will be present

In the closed fracture there will be no physical signs to reveal its presence and only an X ray will determine the diagnosis If it is compound it can be felt with a probe and blood and even brain substance may be seen oozing from the line of fracture While any intracranial complication may follow this type of fracture those regarded as direct results are concussion middle meningeal hæmorrhage and laceration of the longitudinal sinus.

Treatment—If the fracture is compound attention should be directed to the toilet of the wound and the prevention of sepsis with both local and general chemotherapy In every case absolute rest in bed for four weeks is necessary and a close watch kept for intracranial complications In a small percentage of cases delayed symptoms arise many weeks after injury these are grouped under the heading of Traumatic Neurasthenia

Depressed Fractures

A depressed fracture occurs in the vault of the skull as a result of a fall or blow when the injury may be either simple or compound. A punctured fracture is a type of the foregoing being due to a penetrating wound from bullets, shell fragments and the like In all cases there is considerable comminution of bone and in this type spicules of bone may be driven into the brain. It is usual for both tables to be broken simultaneously but occasionally the outer alone is depressed (*e.g.*, over the frontal sinus) or the inner may yield the outer having sprung back without fracture this is rare except in children

Usually the inner table is damaged more extensively than the outer and especially is this marked in penetrating wounds by high velocity missiles The appearance of the depression is of some clinical importance a pond fracture is saucer-shaped having gradually shelving walls whereas a gutter fracture has clean-cut margins below which lies the stove in fragment

Intracranial complications are less likely to occur in this type of injury presumably because the force has been expended in smashing the bone The clinical picture will depend upon the shape size and position of the fragment the presence of an open wound and the integrity of the dura.

Clinical Picture.—*A* A closed depressed fracture is unlikely to occur except in children (Fig 421) It will be covered by a contusion of the scalp and a subpericranial hæmatoma the presence of which will tend to obscure the diagnosis of fracture (cf. p 870) Careful palpation should enable the clinician to recognise (1) the raised edge of the hæmatoma which can be made to pit on pressure (2) the edge of the gap in the skull and (3) in the centre the depressed fragment lying definitely below the level of the skull surface The associated intracranial lesions vary considerably from mild concussion to extensive laceration of the brain These are not usual, however and the patient rapidly improves. If no treatment is adopted and the fragment allowed to remain depressed delayed symptoms are likely though not certain to occur These are headache giddiness and traumatic epilepsy All cases of depressed fractures of the forehead require operation for elevation of the fragment for cosmetic reason



FIG. 421

A small boy with a depressed fracture in the right temporo-frontal region. The superficial bruising and the extravasation of blood into the upper eyelid is well shown.

B Compound depressed fracture can hardly escape immediate diagnosis An open wound is present the hæmorrhage is profuse and the depressed fragment can be felt or seen. If the dura is torn cerebrospinal fluid and possibly even brain substance appear in the wound. The intracranial lesions associated with this type of injury may be surprisingly slight but its true significance lies in the grave dangers likely to follow the advent of sepsis in the wound.

C Punctured wounds are always compound but differ somewhat from those described above in that the wound of entry is small but the underlying tissues are seriously damaged A bullet for instance will cause a punctured wound of entry while the bone is fractured and depressed and extensive laceration of the brain by both missile and indriven bone occurs These wounds are even more sinister in their possibilities and must never be judged by the size of their wound of entry

Treatment.—Certain general principles govern all treatment They are (1) prevention of sepsis (2) elevation of the depressed fragment and (3) appropriate attention to associated intracranial lesions

Simple depressed fractures in children should not be operated upon at first because a great many recover spontaneously If later elevation of the fragment is deemed necessary all bruising of the soft tissues will have subsided and the danger of infection thereby lessened. In adults there is some difference of opinion as to the correct treatment It is

well to operate when the fracture is over the motor or speech cortex When over silent brain areas elevation of the bone is not so important

Compound fractures must invariably be submitted to operation, in order to render the wound as aseptic as possible The head is shaved and cleansed, the wound excised and the bone exposed by a large curved incision which allows a flap to be turned down. All loose spicules of bone are removed and the depressed fragment levered up into position. If the dura is intact this will suffice the flap being replaced and firmly sutured with a small wick of rubber tissue drainage the whole area being dusted with penicillin powder

If the dura has been torn its edges must be trimmed and the exact extent of the damage gently investigated All foreign material must be removed from the track and damaged cerebral tissue washed out by a stream of warm saline or aspirated through a suction tube Gentleness of handling and thoroughness of the cleaning up process are equally important if gross sepsis is to be avoided The "sew up" should be water tight to prevent fistula of cerebrospinal fluid or hernia cerebri A free graft of fascia lata or temporal fascia may be required to replace missing dura. The use of penicillin powder makes this a safe procedure except in exceptionally soiled or late cases when a drain may be required.

In gunshot wounds the internal damage is usually far more serious than the external appearance suggests. They will demand extensive exposure and most thorough exploration together with meticulous care in cleansing and drainage

The complications of a depressed fracture are primarily concerned with infection, and a careful watch must be kept during convalescence for osteitis of the broken bone extradural abscess meningitis or cerebral abscess An uncommon sequela of uninfected closed fracture is known as a Traumatic Cephalhydrocele. It appears in about a week after injury when the hæmatoma is subsiding as a soft fluctuating swelling It is of slow growth painless reducible on pressure has an impulse on coughing and may pulsate It contains cerebrospinal fluid which has escaped through a rent in the dura and a crack in the bone and has come to lie either beneath the pericranium or more probably in the subaponeurotic space

Treatment is not necessary for the small ones but if they continue to enlarge it is wise to expose the pedicle and close the dural defect Good results are also obtained by repeated aspirations

FRACTURES OF THE BASE OF THE SKULL

The base of the skull is considerably weaker than the vertex. The bone itself is thinner in places especially in the floor of the three fossæ, while it is further weakened by a large number of foramina of varying size which afford transit to important vessels and nerves

Fractures of the base therefore are far more common than those of the vertex The great majority are due to indirect violence the head coming into violent contact with some object and only a small proportion are the result of direct injury Examples of this latter are

penetrating wounds of the nasal cavities roof of the mouth or orbit and fractures produced by impact of the vertebral column when a patient falls from a height on to the feet or buttocks Fractures due to indirect violence follow a force applied to the vertex which being elastic, yields but does not break. The base being rigid gives way either because a fissured fracture from the lower aspects of the vertex radiates into the base (Aran's Theory) or from a bursting or compression force This latter theory is founded on the elasticity of the cranium when a heavy force acts on the skull in one axis a narrowing must occur in it and this is accompanied by a widening or elongation in the opposite plane If the limit of elasticity is exceeded a bursting fracture will result

The fracture is usually fissured in type and its line may pass in any direction so that it affects one or all of the fossæ The great majority are compound although the surface wound is rarely apparent and can be deduced only from the symptoms Thus a fracture of the anterior fossa opens the nasal cavity via the cribriform plate the ethmoidal or sphenoidal air sinuses that of the middle fossa enters the nasopharynx middle ear or external auditory meatus that in the posterior fossa may communicate with the nasopharynx, but is less likely to be compound than any of the others If the dura also is breached the subdural space is vulnerable to direct spread of infection from the exterior and meningitis may follow

The intracranial lesions associated with a fracture of the base are usually severe and extensive contusion or laceration of the brain must be expected. The complications directly attributable to the fracture concern injury to those vessels and nerves which pass through the foramina in the base of the skull so that extradural hæmorrhage and lesions of the cranial nerves are commonly seen

Clinical Picture.—It must be understood that a fractured base will probably give no signs referable primarily to itself and its presence must be deduced from other evidence This includes —

1 External hæmorrhage from the ear nose and mouth
2 Hæmorrhage into the eyelids and beneath the conjunctiva—the anterior fossa black eye
3 Escape of cerebrospinal fluid from the nose ear or mouth.
4. Involvement of cranial nerves of which the VIIth and VIIIth are the most significant.

It is convenient to group these fractures under the heading of the fossa implicated. It will be remembered however that more than one is involved in many cases

A **Anterior Fossa.**—The salient features are a *characteristic* extravasation of blood into the orbits and *external* bleeding from the nose and mouth. Some of this blood will be swallowed and appear later in the vomit Cerebrospinal fluid is likely to escape into the nose and mouth, but its presence will probably not be recognised owing to its admixture with blood. The *orbital* bleeding first appears at the lower and outer part of the conjunctiva, spreads forward from the back of the orbit and finally reaches the corneal margin around its

entire circumference Simultaneously bruising becomes apparent in the lower and then the upper eyelid, but the typical purple discoloration stops short at the orbital margins and never encroaches either on the face or forehead. In these ways can an "anterior fossa black eye" be distinguished from one due to local trauma

Fractures of the accessory sinuses and cribriform plate in addition

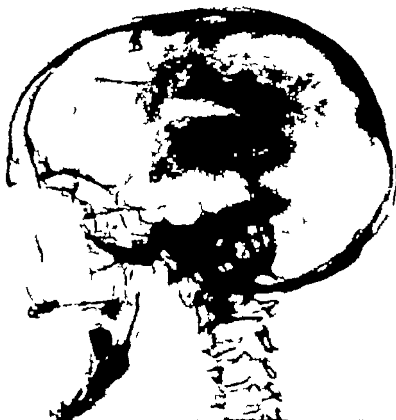


Fig 422

An X-ray showing air over the cerebral convolutions A, encysted in the cortex B and in the ventricle C The hole D marks the site of bone removed to evacuate an extradural hæmatoma. The fracture can be seen just above the hole, and the groove for the middle meningeal artery below it

to allowing cerebrospinal fluid to escape also permit ingress of air when the patient blows his nose The air may (1) form a localised pneumatocele (2) spread over the cortex of the brain or (3) even fill the ventricles Fig 422 is an excellent example of all these three types of air collection after a fractured skull involving the frontal sinus.

The nerves liable to injury are the Ist IInd, IIIrd, IVth first division of the Vth and the VIth occasionally producing anosmia, blindness, ophthalmoplegia or anæsthesia of the forehead.

B **Middle Fossa.**—The majority of fractures of the base involve the middle fossa, and show a marked tendency to pass through the petrous portion of the temporal bone thereby implicating the tympanic cavity and possibly tearing the tympanic membrane In those fractures both blood and cerebrospinal fluid will probably escape from the external auditory meatus often in considerable quantities The blood is dark in colour flows continuously and is apt to persist for several days whereas the bleeding from a simple tear of the tympanic membrane is bright red and of short duration.

In this situation the involvement of cranial nerves constitutes the most important aspect of the picture for the second and third divisions of the Vth nerve the VIth VIIth and VIIIth nerves are all dangerously placed. The facial and auditory nerves are more frequently injured than all the others and they may be damaged in several ways Either they are torn across at the time of accident compressed by blood clot in their canals in the temporal bone or later interfered with by subsequent callus formation. The symptoms and signs of facial palsy and of deafness may therefore appear either immediately within the first five days or after a period of some weeks The deafness may be due to damage to the labyrinth rather than to the nerve itself or to interference with the ossicles in the middle ear In all cases the prognosis with regard to hearing is poor The prognosis for recovery of the facial paralysis is better than for hearing

C **Posterior Fossa.**—External bleeding is unlikely to occur but after a few days bruising will make its appearance behind and below the mastoid process in the neck. The intracranial damage is probably severe but there will be no symptoms directly due to the fracture

Prognosis—The future of a patient after a head injury depends almost entirely upon the extent and nature of injury to the contents of the skull, and the fracture of the cranium has little if anything to add to those data which are being weighed in the balance *Suffice it* to say that a simple uncomplicated fracture of the skull is of less significance than that of a long bone in the lower limb

Treatment is devoted to the relief of complications A simple fracture without associated lesions needs rest in bed for fourteen days a similar injury with concussion demands twenty-eight days in bed, and in neither case may the patient return to work before eight weeks have elapsed. Treatment of those fractures accompanied by intracranial lesions is dictated by the requirements of these latter and not by the bony injury

Bleeding and loss of cerebrospinal fluid from the ear deserve a special word of warning Once every day the external meatus must be gently swabbed to remove blood clot and *debris* Its opening is carefully bathed with a warm solution of mild antiseptic and then lightly plugged with sterile wool. On no account must the ear be syringed, and it is wiser to postpone inspection of the drum with a speculum till the seventh day Dusting a little penicillin and sulphonamide powder into the meatus is of value to prevent infection of the discharges

Loss of cerebrospinal fluid almost always ceases spontaneously but

certain rare cases of liquorrhoea through the cribriform plate occur in which the loss may be so great and so persistent that an operation must be done to arrest it. The frontal lobe is exposed and raised, the rent in the dura identified and a small muscle or fascial graft inserted after closing the perforation with a stitch.

Facial palsy may call for surgical measures to relieve pressure on the nerve If there is reason to believe that the nerve is injured in the Fallopian aqueduct muscle weakness is persisting and the reaction of degeneration present the nerve must be exposed and decompressed, the wall of the canal being removed and the fibrous sheath slit up

DISEASES OF THE SKULL

CONGENITAL ANOMALIES

Congenital Aplasia Cranii is a condition of incomplete ossification of the skull which may persist into adult life It is a rare defect seen only in children borne to an enfeebled mother No treatment is of any avail.

Cephaloceles are protrusions of the dura mater with or without brain tissue through an opening in the bone being similar in many respects to spina bifida. They are due to the failure of the mesoblast completely to enclose the primary cerebral vesicle so that a small portion of the latter is left outside the skull with a channel of communication to the dura passing through the bone Cephaloceles are covered by normal skin, but this may become thinned and adherent if the swelling reaches a great size They are seen only in certain situations, commonly at the root of the nose and in the occipital region and very rarely in the neighbourhood of the anterior fontanelle the ear and mastoid process or even in the basisphenoid area, thereby bulging the posterior pharyngeal wall. They indicate an increase in intracranial pressure and are associated with some degree of hydrocephalus Other congenital anomalies such as spina bifida, cleft palate or hare-lip are often present in these cases Three varieties are described.

1 MENINGOCELE is a protrusion of dura containing only cerebrospinal fluid and is the commonest form, being found in the occipital region It presents a soft fluctuating swelling which is translucent, reducible on pressure and pulsates with respiration but not with the heart beat It becomes larger and more tense when the child strains cries or coughs. Gentle pressure reduces the swelling but causes vomiting and possibly convulsions The skin and hair are normal over the smaller varieties which tend to remain stationary in size while the larger ones progressively increase so that the skin becomes thin and finally bursts the child dying from meningitis.

2 ENCEPHALOCELE occurs at the root of the nose The swelling is less soft does not transmit light, and pulsates synchronously with the heart. Pressure causes convulsions while spastic paralysis and altered reflexes are usually present

3 MENINGOCEPHALOCELE is seen in the occipital region either above or below the level of the tentorium It is always associated with hydrocephalus and a portion of the posterior cornu of the lateral ventricle may be included in the sac. *It is probably incompatible with life*

Prognosis is exceedingly poor Death is likely at an early age, and if the child survives it will be subject to fits and of feeble mental development

Treatment—Small simple meningoceles can be excised and the *opening in the dura closed* but in nearly every case a hydrocephalus will follow In other patients aspiration succeeded by firm bandaging may arrest the increase in size

Craniostenosis is produced by premature fusion of the cranial sutures in childhood. Several deformities result —

1 *Microcephaly* when all the sutures are affected For some reason this does not always produce increased intracranial pressure and blindness does not inevitably result
2 *Oxycephaly* with high forehead and egg-shaped skull.
3 *Brachycephaly* with broad head.
4 *Dolichocephaly* with long head.

The last three are associated with characteristic deformities and are due to premature closures of certain sutures which prevent *growth* in certain directions and so uneven growth occurs. Increased *intracranial* pressure papilloedema and blindness almost invariably result and can be prevented by cutting wide gutters over the fused sutures. There is often no headache and the blindness may be insidious so there should be no hesitation in operating on these cases as soon as they are definitely apparent *Macrocephaly* on the other hand, is not always a cause of mental deficiency as all the structures of the head are larger than normal Historical examples of this condition are those of Lord Byron and Bismarck.

INFLAMMATORY DISEASES OF THE SKULL

Acute Osteomyelitis is an inflammatory process due to pyogenic cocci. *Its pathology is* similar to that in long bones except in *certain* respects. The infection is rarely carried to the skull by the blood stream, but reaches it from a focus of local disease or injury Thus infected scalp wounds and compound fractures are common causes whilst the bone can be involved by direct *spread from the frontal sinus* or intracranial suppuration. The inflammation does not necessarily affect both tables at first, but later both pericranium and dura are lifted off the bone by the inflammatory exudate Sequestra form in the same way as in a long *bone* but take an unduly long time to separate The pericranium seems unable *to* produce an involucrum and the defect may be closed only by a thick fibrous membrane although in some cases a new calvarium is regenerated from osteoblasts attached to the dura The necrosis is *limited* at first by the sutures to *the bone primarily infected but the* infection can jump the sutures

Symptoms—The onset is sudden *headache* local pain and a rigor usher in the disease The temperature is high (*104* to *105°* F) and there is a tender swelling over the affected *bone* At first tense and

indurated, this area softens and fluctuates as pus is formed. A particular type of swelling is seen in certain cases of extradural abscess sometimes associated with a fracture of the skull It appears some days after the onset of the illness as a localised boggy œdematous tumour to which the name "**Percival Pott's Puffy Tumour**" is given.

Prognosis in this disease has been completely transformed since the advent of the antibiotics and it is rare to have an infection which will not yield to one of them

Treatment consists in the aspiration of the abscesses as they appear and the injection of the cavities with the appropriate antibiotic, maintaining all the time a complete readiness to intervene surgically if intracranial suppuration manifests itself

Treatment should be instituted at the earliest possible moment The outer table is excised to ensure free drainage to the infected diploe if signs of extradural abscess are present the inner table also must be removed. The later procedure is a matter of controversy one school advocating radical removal of bone another advising drainage of abscesses as they occur and picking out sequestra when loose Nafziger's method is ingenious consisting in removing the whole plaque of diseased bone with a generous margin. This removed bone *is boiled and kept in safety for six months and restored to its bed after* all sepsis has died down Intensive chemotherapy will be started immediately the diagnosis is made

Chronic Osteoperiostitis of the skull is usually syphilitic but a number of simple cases occur as a result of a blow or long-continued pressure as, for example in Covent Garden porters who carry piles of baskets on their heads The new bone which takes the form of a node should be chiselled away only if it is causing definite pain.

Tuberculous Disease of the skull is one of the least common manifestations of this infection. It usually occurs within the vault in young people but may be seen in the mastoid process or malar bone The organisms reach the bone either via the diploic vessels or the meninges. *Caries follows, the inner table being more extensively* diseased than the outer Headache local pain and tenderness call attention to the condition and an X ray photograph will reveal the caries. It is wise to operate before an abscess makes its appearance for the results of early radical removal are far superior to palliative measures The disfiguration from radical removal should not deter the surgeon as plastic procedures at a later date will remedy the deformities The use of streptomycin locally and generally is of great value in obtaining early healing

Syphilitic Disease of the skull is seen both in the tertiary stage of the acquired form and in congenital syphilis. These manifestations are described in full in Chap XLVII

NEW GROWTHS OF THE SKULL

Osteomata of both types occur in the skull their general pathological characters differing in no way from those seen elsewhere *Cancellous osteomata* are not common in the skull whereas *ivory*

exostoses are seen only in the bones of the head They grow from either table projecting inwards towards the brain or outwards beneath the scalp The ivory osteoma can occur anywhere in the skull but favours the neighbourhood of the organs of special sense and may consequently interfere with their function These tumours are readily diagnosed by X-rays and their removal is indicated for either pain or deafness A very peculiar complication of these tumours is cerebrospinal liquorrhœa from the nose when the osteoma involves the accessory sinuses

Hæmangiomata arise in the diploë and cause a characteristic area of destruction of bone

Sarcoma arises either in the pericranium diploë or dura It is spindle or round-celled and exhibits the utmost rapidity of growth So true is this, that the swelling may be mistaken for an inflammatory process the rapid onset redness, heat and softness of the tumour suggesting this type of lesion Prognosis is hopeless and treatment of no avail

Secondary Carcinoma is commonly met with in malignant disease of the breast thyroid, kidney testis and prostate Frequently a large number of malignant emboli are widely scattered throughout the diploë and X rays show a very typical moth-eaten appearance The skull may also be involved by direct spread from a squamous celled carcinoma of the face or scalp

Osteosarcomatous Metastases seem to have a special affinity for the skull, as does multiple myeloma. **Chloroma** is a peculiar greenish small round-celled tumour having a predilection for the orbit and cranial bones, and associated with the blood changes of myeloid leukæmia. **Neurocytoma** of the adrenal medulla tends to metastasise to the orbit and skull bones on the same side of the body as the primary tumour (Hutchison s syndrome) **Cholesterin deposits** from faulty lipoid metabolism occur in the skull in Hand-Christian Schüller disease in which blindness may result from pressure on the optic nerve **Eosinophilic granuloma** is a peculiar bone destroying tumour in the skull bones in the neighbourhood of the orbit It generally follows trauma and is almost certainly allied to the lipoid deposits in the skull bones

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CHAPTER XLI

THE BRAIN AND ITS COVERINGS

SURGICAL *Anatomy and Physiology*.—So complex is the structure of the brain, so diverse and complicated are its functions, that it is impossible for lack of space to enter here upon a description of either. The science of neurology has become a vast specialised subject, and the student must master its essentials before he can aspire to an understanding of the many diseases to which the brain is subject. The intracranial problems which come within the sphere of surgery are concerned chiefly with injury and new growths. Underlying all these lesions is an increase in intracranial pressure which in its turn is dependent on disturbances of the circulation of blood within the skull.

Physiology of Intracranial Circulation.—It must constantly be borne in mind that (1) *the brain and its vessels are enclosed within an unyielding box* (the skull) and (2) the vessels inside it are devoid of vaso-motor nerve supply.

Blood enters the rigid box by the internal carotid and vertebral arteries at a pressure equal to that in the extracranial portion of the internal carotid artery, viz. about 130 mm of mercury. It leaves the skull by the internal jugular veins, the pressure in which is susceptible to respiratory variations of between minus 5 mm. and 30 mm. of mercury. During its passage through smaller arteries, arterioles, capillaries, venules, veins and venous sinuses, the circulating blood is evidently at successively falling pressures. Nevertheless the volume of blood leaving the skull under normal conditions *must* necessarily be equal to that entering. The explanation of these two apparently contradictory facts is that the calibre of the venous outlet greatly exceeds that of the arterial inlet. A large quantity of sluggishly moving blood is contained in soft-walled, easily compressible venous sinuses just before leaving the skull. It is evident that these latter can accommodate themselves to a considerable external pressure before their calibre is diminished to the point at which it would approximate to that of the arteries. Up to this moment the only result would be to accelerate the venous flow.

The intracranial circulation therefore should be considered under three headings:—

(a) The arterial system, the pressure in which is always that prevailing in the internal carotid, *i.e.*, about 130 mm. of mercury.

(b) The capillary system. In so far as the capillary network may be regarded as a skeleton framework on which brain tissue is built the capillary pressure is in effect that of the brain itself.

(c) The venous and cerebrospinal fluid systems in which the pressure is maintained at an equal level. In quiet respiration this varies between 0 and 10 mm. of mercury. It must be regarded as the general intracranial pressure.

EFFECTS OF INCREASING INTRACRANIAL PRESSURE

These can best be illustrated by taking as an example a persistently increasing hæmorrhage from the middle meningeal artery These effects to which the clinical picture is closely allied will be described in three stages.

Stage I.—Since the skull is rigid the escaping blood must displace some of the intracranial contents and the most easily compressible structures will be the first to feel the effects Thus the thin walled venous sinuses will be slowly pressed upon, so that their capacity diminishes The process continues until the calibre of the venous outlet has been made equal to that of the arterial inlet Venous blood will be expelled from the skull at a greater rate than normal but is not impeded in any way Clinically then this may aptly be termed the silent stage

Stage II.—After this point has been reached further hæmorrhage will compress the venous channels still more with the result that the flow of blood is now definitely obstructed. A condition of venous congestion is established and experimentally this has been demonstrated by the appearance of cyanosis of the brain. Clinically this results in increased excitability in all its areas, the stage of irritative phenomena."

Stage III.—If bleeding still continues the blood can find more space only by compressing the capillaries as the venous sinuses are already collapsed. Within the skull the capillary pressure is synonymous with that of the brain tissue so that in fact the brain itself is being compressed. Experimentally this is demonstrated by the sudden transition from the blue colour of cyanosis to the dead white of anæmia. Clinically this may be translated into the stage of paralysis

Clinical Picture.—*A* The brain regarded as a whole The following table, modified from Wilfred Trotter and Julian Taylor in Choyce s System of Surgery gives a concise idea of the leading symptoms

	STAGE II	STAGE III
	Cerebral Hemisphere	
Consciousness	Irritability delirium, slowness, drowsiness.	Coma.
Motor cortex	Rigidity Jacksonian fits.	Hemiplegia, exaggerated reflexes, positive Babinski s sign absent abdominal reflexes
	Mid-brain	
Oculomotor nerve	Contracted and sluggish pupil.	Dilated and fixed pupil.
	Bulb	
Respiratory centre	Deep slow breathing	Slow gasping irregular breathing
Cardiac centre	Slow full pulse	Rapid, small, weak pulse.
Vasomotor centre	Rising blood pressure	Falling blood pressure.

B The brain in its component parts The illustration given assumes that the brain is a solid entity occupying a simple chamber Such of course is not the case for the falx cerebri and the tentorium subdivide the cavity so that the two cerebral hemispheres and all brain tissue lying below the tentorium can be regarded as three separate structures These are not necessarily affected either simultaneously or equally

In practice the successive stages described above although perfectly correct do not involve the brain as a whole but the effects of increasing pressure are first felt in the neighbourhood of the injury Symptoms will be primarily irritative and later paralytic and those parts immediately in contact with the hæmorrhage must be more seriously affected than those at a distance Thus, in the early stages the cerebral cortex adjacent to the blood clot will be anæmic i.e., paralysed whilst the deeper and more distant surface areas in the same hemisphere are cyanotic i e. in the irritative phase Later the whole of one half of the cerebrum will exhibit paralytic phenomena, whereas the opposite half and the mid brain are in a state of irritation. Clearly the whole brain cannot be equally involved unless the patient is past all hope of recovery The clinical picture of Head Injury must vary greatly according to the site of the blow and the nature of its effects Nevertheless this general description, if constantly borne in mind, will simplify the students task in understanding those different lesions a description of which now follows

RESULTS OF HEAD INJURY

CONCUSSION

Nothing is gained by long discussion of the many theories pur porting to explain the cause of concussion the exact nature of which remains unknown.

Symptoms—Severe concussion presents a characteristic picture, although this is usually seen only by eyewitnesses of the accident and rarely by the surgeon Its onset *immediately* follows the blow The victim, having been felled to the ground lies in a flaccid heap in the exact position into which he has collapsed. There are complete loss of consciousness and absolute muscular relaxation, which latter may lead to incontinence of both urine and fæces Pulse and respiration are barely perceptible the former being either rapid or very slow The face is pale cold and clammy the pupils are dilated and do not react to light To the casual onlooker the victim appears to be dead, as indeed may be the case in a very small percentage of such accidents In the majority this near approach to death lasts a few moments (at the most two to three minutes) after which signs of recovery become apparent The pulse can be felt at the wrist weak respiratory movements are visible, and the pupils now react to light Almost immediately an attack of vomiting occurs and the physical effort entailed raises the blood pressure The vital centres are once more

revived with blood, consciousness abruptly returns and muscular control is re-established.

Concussion is not always of this severe type and many milder degrees occur A blow may be followed by a momentary attack of unconsciousness or merely of dizziness A not uncommon example is that of the player knocked out by a heavy tackle at rugby football. After a few moments flat on the ground a somewhat dazed and giddy man resumes his place in the field, which he attempts rather ineffectually to keep If given the ball at an opportune moment he is likely to score even against unexpected odds In the changing room afterwards and at home that evening he will have no recollection of the game or his part in it

Between these extremes many variations occur and it is important to review the results which may follow

1 Severe concussion may lead to death, which in some cases is instantaneous.

2 Severe concussion is almost certainly associated with grave lesions of the brain or of intracranial blood vessels The unconsciousness of concussion will either merge gradually into the coma of severe brain injury or pass off completely—even if later it reappears

3 Uncomplicated concussion quickly passes into the post-concussive phase This includes headache giddiness nausea, sleeplessness, irritability restlessness and a feeling of weakness and insecurity These vary in number and degree in different patients in some of whom complete recovery follows within forty-eight hours, whilst in others distressing sequelæ may persist for a long time One of the most characteristic features of all grades of concussion is the complete loss of memory of the actual accident, and of the few minutes preceding it as well as the succeeding two to twelve hours

Treatment—There is no indication for strenuous resuscitative measures The patient is merely kept horizontal and warm until either he recovers consciousness or drifts into the coma of cerebral laceration or compression. A rapid neurological examination should be made at this stage although rarely is any information of value obtained If there is a laceration of the scalp this should receive attention.

During the next twenty four hours the patient must be kept in bed and watched with the utmost care and attention. The pulse rate is recorded on a special chart every half an hour During this period repeated examinations by an expert neurologist should be carried out In favourable cases the patient will improve and give little cause for further anxiety in others the symptoms and signs of intracranial injury will begin to manifest themselves and it is for the earliest of these that a close watch must be kept in every patient

CONTUSION AND LACERATION OF THE BRAIN

Pathology—The difference between contusion and laceration is one merely of degree The pathological processes which result are (1) hæmorrhage which may be either from surface vessels or into the

brain substance (2) œdema of the brain, and (3) delayed softening of the damaged area. Before defining these more exactly it is necessary to inquire how injuries of the brain occur **Direct Injury** is produced *immediately beneath the point of application of the force* and will obviously vary in extent with the degree of violence, the presence and type of fracture and of foreign bodies **Injury by Contrecoup** is less easy though equally important, to understand. At the moment when a heavy blow falls upon the skull the force travels from the point of impact in a definite direction through the brain to reach the skull at a point along this axis opposite to the area primarily struck At the time of injury the brain is momentarily displaced and comes into violent contact with this zone of bone This part of the brain, therefore may be contused or lacerated with less equal or greater severity than that immediately below the actual point of trauma. This is known as Injury by Contrecoup In the localisation of intracranial injuries this may produce a most perplexing combination of symptoms and signs and must never be forgotten when a head injury is being examined.

Hæmorrhage follows a rupture of the vessels either in the meninges on the surface of the brain or within its substance It is evident that it may be of varying degrees of severity A large vessel rupturing into the subarachnoid space may bleed profusely and cause death within a few moments. Usually it is of slower occurrence and more limited in extent

Bleeding into the brain itself may occur as one large hæmorrhage or as focal points scattered throughout its substance especially along the axis of the harmful force and at the area of contrecoup

Œdema.—The brain substance in the neighbourhood of the lesion becomes œdematous in the same way as does any other soft tissue after injury Œdema of the brain however assumes an altogether unusual significance because of the inelastic skull within which it is contained, as a result of which the space available is strictly limited. The effusion of fluid causes venous engorgement in the tissues sur rounding the contused or lacerated area, but the pressure of the œdema can rarely if ever rise to such an extent that anæmia takes the place of venous congestion. It is clear that the symptoms will be those of irritation and not of paralysis

In many cases there will be multiple focal lesions of œdema and hæmorrhage along the axis of the causative force together with a possible contusion at the zone of contrecoup The extent of œdema therefore is not localised to the lacerated area of brain beneath the site of injury and consequently the clinical picture of irritation is likely to be widespread, even if not severe

Delayed Softening of the damaged area of brain may occur after *several weeks. If a blood vessel of any size is involved in this process* a severe hæmorrhage occurs quite suddenly with a fatal result. This condition is known as Spät Apoplexie of Bollinger

Clinical Picture.—The widespread diffusion of the œdema makes a *clear-cut* description impossible There may be localising signs as a result of interference with the functions of damaged areas of brain

tissue, but chiefly the clinical condition is dominated by the effects of œdema.

Cerebral Irritation is the term used to describe the state of a patient after concussion has passed off. It must clearly be understood that it *does not* imply that the cerebral cortex is being irritated by blood, depressed fragments of bone or other foreign substance but that the brain is in *so excitable a state that* it responds more easily and more violently to stimuli than it would normally do.

The stage of post-concussive *recovery* is *somewhat* protracted, signs of shock persist and return to full consciousness is delayed. Within twelve hours œdema is sufficiently advanced to produce *the state of* irritation. The patient complains of a severe headache, nausea and dizziness, all of which are instantly increased by attempted movement, for which reason he lies motionless and silent. He will be found curled up on one side with trunk and limbs flexed. The eyelids are kept tightly shut for there is marked photophobia. Temperature is slightly raised to but not exceeding 100° F; pulse rate is slow (between 60 and 70) *but the volume* remains good, while respiration is usually quiet, regular and normal in rate. Such is the picture as long as the man remains undisturbed *and the true state* of affairs is not revealed until an attempt is made to question or examine him. Such interference is bitterly resented and he demands to be left *alone*. If the interrogation is pressed, he becomes noisy and angry, mutters or shouts and throws himself about in the bed. Attempts to examine the *pupils are* strenuously resisted. Later, especially during the night, this irritability may pass into delirium and restlessness, so that gentle restraint *may be* necessary. These are sometimes indications that the intracranial lesion is increasing in extent and severity. *As a rule*, however, a patient with typical cerebral irritation will not die from his injuries.

This stage of excitability *lasts for periods* varying between forty-eight hours and fourteen days, after which a gradual improvement sets in, *but a state* of mental confusion *is* apt *to* persist for a considerable time.

Cases of *severe* laceration as a rule pass to an early fatal *issue with rising* pulse and temperature and terminal œdema of the lungs. The onset of bubbling in the trachea is the most ominous of all *signs in* head injuries and indicates a complete cerebral breakdown rather than a terminal broncho-pneumonia. If a miracle occurs and the cranial condition *improves it* is amazing to find how quickly the bronchial mucus disappears and the "pneumonia" clears up.

Treatment aims at the avoidance of *all* exciting stimuli and the reduction of increased intracranial pressure. The patient must be kept completely quiet in a darkened room. Highly *nutritious* food in fluid *form* must be given and is fortunately well tolerated. In the unconscious patient feeding has to be done by a fine rubber tube passed through *the nostril* and reaching the *stomach*. Careful attention to the action of both bowel and bladder is important. If signs of high intracranial tension *appear*, *lumbar* puncture helps especially in the relief of headache. It must *however* be done very carefully. A rubber

tube and glass manometer are attached to the spinal needle and the fluid allowed to run over the top of the manometer which is slowly lowered so that half an hour is spent in reducing the pressure to normal high limits i.e. 100 mm of water Together with this it is wise to administer ½ oz. of magnesium sulphate in 2 oz of water daily or, if the patient is unable to swallow 8 oz of 50 per cent. solution of the same salt is run warm into the rectum. A still stronger method of bringing down the pressure is to inject intravenously (Weed and M Kibben s method) 100 c c of certain hypertonic solutions of which 50 per cent glucose and 15 per cent. saline are suitable examples They cause a rapid absorption of œdema fluid into the circulation by osmotic action and, when judiciously used are of the greatest life-saving value

Restlessness noisiness and excitability may demand the use of sedatives. Morphia and its derivatives should not be used, but 3 gr of sodium luminal intramuscularly is the best sedative for these cases and paraldehyde by intravenous injection is also of great value when the patient is endangering his life by his violent behaviour

COMPRESSION OF THE BRAIN

This is produced by an increase of intracranial tension, the sequence of events in which has already been described. It may be due to intracranial hæmorrhage increasing œdema of the brain inflammatory lesions and tumours Clearly the rapidity with which symptoms appear varies with the cause of the compression thus those of hæmorrhage will be obvious within a few hours those of abscess are delayed for some weeks while a tumour may remain silent for many months or even years.

The term compression is established by long usage but its use is open to grave criticism Too frequently it is used to describe the later stages of increasing intracranial pressure These it will be recalled, are due to anæmia of the brain and are manifested by paralytic symptoms Herein lies the danger for this interpretation must result in failure to recognise the earlier signs of increasing tension It should clearly be understood that the term Compression of the Brain is here used to cover both the pathological changes due to alterations in intracranial circulation and the clinical pictures with which they are associated.

Symptoms and Signs—After a severe blow on the head concussion is an immediate result This is followed by return to consciousness except in those cases in which death occurs at once No matter what may happen afterwards be the intracranial injuries grave or trifling this return to consciousness is almost invariably present It may be so brief as to be momentary or it may last for many hours before the patient slowly sinks into unconsciousness. If the student will turn to the beginning of this chapter he will understand that this period of consciousness corresponds to Stage I—i.e. t[illegible]lent stage of increasing intracranial tension The [illegible]ty of [illegible]d the speed with which it is extravasated a[illegible]n of the stages of

irritation and paralysis but every case does pass through these definitely recognisable phases It will make the description more clear if each system is taken individually

A **Alterations in Consciousness.**—Middle meningeal hæmorrhage provides a classical picture The initial concussion is succeeded by normal consciousness for several hours With the onset of irritation the patient becomes excitable irritable and violent. His mental condition remains perfectly clear but he is not really responsible for his actions As the pressure increases he is offensive pugnacious and resentful and is in fact an exceedingly dangerous "automaton Later consciousness is lost and wild delirium follows Finally as anæmia of the brain occurs the patient rapidly sinks into coma.

If the hæmorrhage is sub-dural and extensive this sequence of events is greatly accelerated. The period of consciousness is momentary and the stage of excitation passes almost immediately into coma to which the patient rapidly succumbs

On the other hand, a very slow hæmorrhage will present a delayed and somewhat variable picture until the limit of toleration is reached when coma abruptly appears.

B **Motor Cortex.**—If the injured area includes the motor cortex and pyramidal tract the irritative stage is marked by muscular rigidity and Jacksonian fits. The muscles affected depend upon the site of injury in the brain, but the whole length of the motor cortex is frequently involved. The defects are naturally seen on the opposite side of the body to the brain injury As pressure increases paralysis will occur and it is possible at some stage to find paralysis of the opposite half of the body and irritative phenomena on the same side as the cerebral damage.

C **Changes in the Pupils** are of the greatest value in diagnosis and can be explained in tabular form, thus —

RIGHT-SIDED CRANIAL LESION

	Right Pupil.	Left Pupil.
Early	Contracted and sluggish, *i.e.*, irritative	Normal.
Medium	Slightly dilated and fixed, *i.e.*, early paralytic.	Contracted and sluggish, *i.e.*, irritative.
Late	Widely dilated and fixed oval, *i.e.*, late paralytic.	Slightly dilated and fixed, *i.e.*, early paralytic.

D **Respiratory Centre.**—In the irritative phase respiration is deep and slow in the paralytic stage stertorous rapid and bubbling. Complete paralysis is an extremely grave sign but provided the patient can be kept alive by artificial respiration he can still be saved if the pressure on the bulb is relieved.

E **Cardiac Centre**—The pulse rate is one of the chief indications of changes in the cranial circulation, and a half hourly record must always be kept. In Stage II it is of full volume but slow falling as low as 30 per minute Later it changes to a rapid, small and feeble

of the fracture on the X ray and the fixed pupil indicates the side for operation

The condition is easily dealt with. A straight incision (Fig 442) is made which allows the temporal bone to be perforated the clot is then sucked and washed out If the bleeding point is difficult to discover the foramen spinosum should be exposed and the artery coagulated by diathermy but almost invariably after the clot has been removed the slight oozing can be dealt with by a small cigarette drain for twenty four hours

The extreme urgency of these cases must be appreciated an hour's delay in operating may make the difference between death and *complete recovery*

Subarachnoid Hæmorrhage is found in nearly all fatal cases of head injury although death may actually be due to laceration of the brain produced by coup or contrecoup The hæmorrhage may be extensive and rapidly fatal or small and localised The clinical picture therefore differs from that of the classical middle meningeal hæmorrhage only in the duration of the various stages There are other chronic **types of subdural hæmorrhage** arising from head injuries quite often but not always of minor degree generally in males after the age of 40 years. In this type the patient after the accident complains of head aches irritability and photophobia this condition slowly passes and about one month later he is alarmed to find symptoms such as hemiplegia aphasia and drowsiness returning Progressive mental changes may be severe and, finally coma sets in Exploration should be carried out by multiple trephine holes on the suspected side and the blood clot washed and sucked out from one trephine hole to the next In certain cases the collection of blood will have formed a loculated cyst to which the name Subdural Hæmorrhagic Cyst is given Should this be found at operation the trephine holes which have been purposefully placed can be linked by a Gigli saw and a flap turned down after which the cyst can be removed with its enclosing membrane The possibility of bilateral hæmatomata should always be kept in mind and the making of small bore holes on the opposite side carried out if there is the slightest indication These conditions are usually found close to and on either side of the superior longitudinal sinus The reason for the long delay between injury and operation in these cases lies in the fact that the blood escapes into the subdural space and does not communicate with the cerebrospinal fluid in the subarachnoid space It is probable that after lying for a time osmotic processes get to work and the volume of the encapsulated clot increases and pressure symptoms appear

Delayed Hæmorrhage, i e Spät Apoplexie of Bollinger has already been described (p 888)

Hæmorrhage from the Venous Sinus common in civilian practice The veno blood pressure is t little bleeding will occur unless the orn. Even so the venous sinuses are unlikely t ous trouble u ed by thrombosis or infection

Intracranial I in Newborn ing an tod labour a subdur e rarely o the f I

It is caused by moulding of the bones and injury to the superior longitudinal sinus There will be some difficulty in getting the child to breathe and its general condition gives rise to considerable anxiety After a few days one of the limbs is found to be paralysed and later convulsions appear The recognition of this condition in newborn infants is difficult in the absence of hemiplegia but extremely important The cyst should be searched for with the needle on both sides of the head and repeatedly aspirated as recommended by Ingraham After a few weeks when the general condition improves exploration for removal of the fibrous capsule should be carried out Failure to do this will result in impairment of cerebral growth with resultant hemiplegia and mental retardation

SEQUELÆ OF HEAD INJURIES

Traumatic Neurasthenia is a common and sometimes very troublesome result of head injury especially when litigation is pending It includes a change for the worse in the patient s mental outlook and disposition He complains of headache giddiness inability to con centrate insomnia and phobias of various descriptions He believes himself unable to work and is consumed with worry and anxiety Treatment is difficult but consists chiefly in prolonged rest Operation can do no good, but the favourable settlement of claims for compensation may work wonders.

Headache is a very common and distressing sequel to many head injuries Pain is produced or aggravated by violent exercise stooping worry mental or ocular effort and changes in the weather (barometric headache) Pain localised to a small area is likely to have an organic cause such as scarring and thickening of the meninges or damage to the brain These latter cases may benefit by decompression.

Epilepsy takes the form of either grand mal, petit mal or focal i e., Jacksonian type Encephalography should be carried out in these cases in one of three ways (*a*) réparage in which 20 c c. of air are injected by lumbar puncture no fluid being withdrawn (*b*) replacement of 70 to 150 c.c of cerebrospinal fluid by a slightly less quantity of air or oxygen or (*c*) 50 to 70 c c injected by cisternal puncture Skiagrams may show obliteration of the subdural space by adhesions or cyst formation and operative procedures are planned accordingly

A damaged area of brain, the focus of epileptic seizures can often be located by electro-encephalography the Berger waves showing a slowing and increased amplitude over these areas If good localisation is obtained exploration and excision of the damaged cortex are always worth doing and produce 50 per cent of favourable results in those who do not respond to the usual anticonvulsant drugs (luminal and epanutin) During the course of the operation electrical readings from the exposed surface may be of value as suggested by Earl Walker who maintains that the brain substance adjoining the scar *originates* the abnormal waves rather than the scar itself so that excision of the scar alone may be inadequate

Cranial Nerve Injuries.—Blindness in one or both eyes may result from fractures traversing the optic foramina Sometimes a chronic arachnoiditis develops in the chiasmal region and produces scotomata and other irregular visual field defects and sometimes total blindness There should be no hesitation in exploring either type of case and relieving the pressure on the nerves which may be due to arachnoid bands, cysts or involvement of the optic foramen in the fracture

Permanent damage to any of the cranial nerves can result from fracture of the base but in only one of these (the facial) is any operative interference of occasional value.

Prevention of Sequelæ—Many of the results of head injury can be prevented by proper treatment. Once again emphasis is laid on the necessity for absolute rest during a long period in all these patients.

INFLAMMATORY LESIONS WITHIN THE SKULL

MENINGITIS

Meningitis may be a complication of any compound fracture of the skull, *especially those of the base causing cerebrospinal fistulæ* into the nose or ear It also follows infected lesions of the cranial bones of the accessory nasal sinuses and the mastoid antrum and finally it occurs as a manifestation of certain specific infections which reach the meninges by the blood stream.

The exudate may be either serous or purulent generalised or localised and affects either the outer aspect of the dura or the three membranes together From a clinical point of view little is to be gained by pursuing these subdivisions further The picture is a combination of increased intracranial pressure and an acute inflammatory process. The whole problem of prognosis and treatment has been entirely revolutionised since the advent of penicillin Intramuscular injections however may fail to affect any improvement Many cases respond to intrathecal injections but the surest method of placing penicillin in the required area is by ventriculo-puncture Systemically administered sulphonamides and streptomycin penetrate the blood brain barrier which is closed to penicillin and should be used in all cases of meningitis threatened or established, even before the infecting organism is identified because delay is so serious in these cases. Even tubercular meningitis previously having a 100 per cent mortality has now a 50 per cent cure rate with streptomycin therapy

EXTRADURAL ABSCESS

This follows septic compound fractures osteomyelitis of the skull and suppurative lesions of the mastoid antrum and frontal sinus. The boggy swelling of the scalp known as Pott's Puffy Tumour has already been described (p 882) If untreated meningitis sinus thrombosis or cerebral abscess will follow

Symptoms are pyrexia, localised pain and tenderness and mild signs of increased intracranial tension. These abscesses vary considerably

in their virulence and especially as a complication of middle-ear disease may run a prolonged and chronic course

Treatment is that of the cause The abscess must be given adequate drainage all dead bone being removed and the primary lesion receiving appropriate attention Penicillin has greatly improved the prognosis in this condition

ABSCESS OF THE BRAIN

Pathology—A localised inflammation of the brain may proceed to softening and suppuration, surrounded by an area of œdema Such an abscess may run a rapid course and within one to three weeks lead to definite symptoms of increased intracranial tension Others are of such low virulence that they become encapsuled and after many months produce a picture clinically indistinguishable from that of a cerebral tumour

Causation—1 **Direct Implantation** of infection occurs in compound fractures and penetrating wounds.

2 **Local Spread** of an infected exudate from neighbouring foci is unfortunately very common It is frequently met with as a complication of mastoid suppuration and to a less extent of frontal sinusitis In the former instance the abscess is either in the temporal lobe or cerebellum. Abscess in the temporal lobe results from perforation of the roof of the tympanum the pus spreading into the brain, so that the collection is wholly within the cerebral tissue In the sub-tentorial region infection tracks through the posterior wall of the tympanum, and cerebellar abscess is usually associated with lateral sinus thrombosis and extradural suppuration (see p 401)

Frontal sinusitis and cranial osteomyelitis account for a small number of abscesses which, unfortunately do not always lie immediately beneath the septic area as do those in middle-ear disease An example is an abscess of the frontal lobe on the opposite side to the infected sinus Careful neurological and possibly ventriculographic examination may therefore have to be made in these cases

3 **Pyæmic Abscesses**, although infrequent in ordinary pyæmia, are a common complication of chronic pulmonary infections especially bronchiectasis and empyema In these diseases the abscesses of the brain are often multiple

Symptoms—Brain abscess produces symptoms due to inflammation, increased intracranial tension and its anatomical localisation The clinical picture of abscess is commonly grafted upon that of the causative lesion, so that the one passes gradually into the other

Temporal lobe abscess is accompanied by localising signs of great value in diagnosis Those will include hemiplegia starting in the opposite hand, Jacksonian fits and possibly a homonymous hemianopia If the lesion is on the left side aphasia and word blindness will be present

Cerebellar abscess is likely to produce affections of the Vth to XIIth cranial nerves Signs of true cerebellar involvement are nystagmus inco-ordination of movement and weakness in the limbs,

especially on the same side as the lesion This weakness does not involve the face and the affected muscles are flaccid (Fig 423)

Treatment—In every case energetic chemotherapy is instituted immediately the diagnosis is made If the abscess is secondary to middle-ear disease or frontal sinusitis these must be treated radically The abscess itself is aspirated through a small burr hole and injected with a solution containing 100 000 units of penicillin and 0 1 grm of streptomycin and 2 c c of thorotrast Future injections consist of penicillin or streptomycin alone according to the sensitivity of the organism This method is so effective that all other methods have been superseded The thorotrast will outline the cavity of the abscess and if X rays reveal its persistence in any size it may be dissected out like a tumour If in spite of the aspirations and chemotherapy



FIG. 423
Cerebellar abscess.

the patient s condition deteriorates there should be no hesitation in opening widely and removing all infected tissue (Lebeau) There need be no fear of meningitis even if the ventricle is opened with adequate chemotherapeutic cover The disaster of rupture of the abscess into the ventricles (pyocephalus) has lost its inevitably fatal outcome with the help of chemotherapy and ventricular lavage

SINUS THROMBOSIS

Thrombosis of the cranial venous sinuses may follow suppuration in the mastoid air cells (lateral sinus) and in the frontal sinus (superior longitudinal sinus) When the lateral sinus thromboses in ear cases rigors occur and the patient becomes very ill often with a tender swelling in the neck over the jugular vein Sometimes the nerves which share the foramen lacerum medium with the jugular bulb become involved producing the jugular syndrome of IXth Xth and XIth cranial nerve palsies The treatment consists in proximal ligation of the jugular vein after opening the sinus in the mastoid wound The superior longitudinal sinus thrombosis is more serious and paralysis of both legs may develop and spread to the arms as a result of

infarction of the motor cortex This syndrome is associated with the names of Sargent and Holmes

Other cases of thrombosis occur as a result of trauma and operations and others in debilitating illnesses such as gastro-enteritis in children, chlorosis in young girls typhus etc This type is known as marantic thrombosis

The cavernous sinus may thrombose spontaneously and this being a non-septic process a large number of cases recover Septic thrombosis follows in the wake of orbital cellulitis facial erysipelas carbuncle of nose or upper lip severe dental sepsis and otitic suppuration In facial cases the septic process is carried by the ophthalmic vein and in aural cases by the petrosal sinus The appearance of a case of this condition is unmistakable the lids being terribly swollen, the eyeball proptosed and fixed the pupil inactive and the eye blind while the fundus if it can be seen through the hazy media of the eye shows hæmorrhages and intense congestion The patient suffers most agonising pain and of course has signs of severe septic infection. Penicillin has transformed this situation which always ended fatally previously After the septic storm has subsided, pyæmic abscess in the lungs and empyema may require drainage as may a residual orbital abscess.

HYDROCEPHALUS

Hydrocephalus is a condition of dilatation of the ventricular system In congenital cases it is observed at birth or soon *after* and because *the* cranial bones are unfused the head goes on enlarging and the bones never join completely (Fig 424) In acquired adult cases the same enlargement of the head is not permitted and *that of the* ventricles is at the expense of the compressed brain tissue The cases due to tumours of the 3rd ventricle and posterior fossa need not be considered as the treatment of the hydrocephalus is the removal of the tumour or a *short circuiting* operation such as Dandy or Torkildsen recommend.

There is another group due to post inflammatory obstructions of the cerebrospinal fluid pathways Meningococcal meningitis causes a large number of such *cases* but there are others of unknown etiology The obstruction occurs at the foramen of Majendie the aqueduct of Sylvius or at the *opening* in the tentorium at the first two sites the cavity of the hydrocephalus does not communicate with the spinal theca whereas it does so in the third position the *terms closed* and communicating hydrocephalus describe the two types. They are easily separated by the *injection of 10* c c. of air into the spinal theca in the sitting position and an X ray of the head will *demonstrate* if the air reaches the ventricles. The *diagnosis is* generally made by ventriculography and operation should be undertaken to free the obstruction by dividing adhesions or evacuating cystic *collections* Some gratifying results are obtained but unfortunately in many cases the adhesions re-form after operation and the condition recurs. Tuberculous meningitis "cured" by streptomycin now causes a number of cases

especially on the same side as the lesion This weakness does not involve the face and the affected muscles are flaccid (Fig 423)

Treatment—In every case energetic chemotherapy is instituted immediately the diagnosis is made If the abscess is secondary to middle-ear disease or frontal sinusitis these must be treated radically The abscess itself is aspirated through a small burr hole and injected with a solution containing 100 000 units of penicillin and 0 1 grm of streptomycin and 2 c c of thorotrast Future injections consist of penicillin or streptomycin alone according to the sensitivity of the organism This method is so effective that all other methods have been superseded The thorotrast will outline the cavity of the abscess and if X rays reveal its persistence in any size it may be dissected out like a tumour If in spite of the aspirations and chemotherapy



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infarction of the motor cortex This syndrome is associated with the names of Sargent and Holmes

Other cases of thrombosis occur as a result of trauma and operations and others in debilitating illnesses such as gastro-enteritis in children chlorosis in young girls typhus etc This type is known as marantic thrombosis

The cavernous sinus may thrombose spontaneously and this being a non-septic process a large number of cases recover Septic thrombosis follows in the wake of orbital cellulitis facial erysipelas, carbuncle of nose or upper lip severe dental sepsis and otitic suppuration In facial cases the septic process is carried by the ophthalmic vein and in aural cases by the petrosal sinus. The appearance of a case of this condition is unmistakable the lids being terribly swollen the eyeball proptosed and fixed the pupil inactive and the eye blind while the fundus if it can be seen through the hazy media of the eye shows hæmorrhages and intense congestion. The patient suffers most agonising pain and, of course has signs of severe septic infection Penicillin has transformed this situation which always ended fatally previously After the septic storm has subsided, pyæmic abscess in the lungs and empyema may require drainage as may a residual orbital abscess

HYDROCEPHALUS

Hydrocephalus is a condition of dilatation of the ventricular system. In congenital cases it is observed at birth or soon after and because the cranial bones are unfused the head goes on enlarging and the bones never join completely (Fig 424) In acquired adult cases the same enlargement of the head is not permitted and that of the ventricles is at the expense of the compressed brain tissue The cases due to tumours of the 3rd ventricle and posterior fossa need not be considered, as the treatment of the hydrocephalus is the removal of the tumour or a short circuiting operation such as Dandy or Torkildsen recommend.

There is another group due to post-inflammatory obstructions of the cerebrospinal fluid pathways Meningococcal meningitis causes a large number of such cases but there are others of unknown etiology *The obstruction occurs at the foramen of Majendie the aqueduct of Sylvius* or at the opening in the tentorium at the first two sites the cavity of the hydrocephalus does not communicate with the spinal theca, whereas it does so in the third position the terms closed and communicating hydrocephalus describe the two types They are easily separated by the injection of 10 c c of air into the spinal theca in the sitting position and an X ray of the head will demonstrate if the air reaches the ventricles The diagnosis is generally made by ventriculography and operation should be undertaken to free the obstruction by dividing adhesions or evacuating cystic collections Some gratifying results are obtained but unfortunately in many cases the adhesions re-form after operation and the condition recurs. Tuberculous meningitis cured by streptomycin now causes a number of cases.

Other ingenious operations have been designed for hydrocephalus as for example —

Dandy's operation viz. the removal of the lamina terminalis (anterior wall of the 3rd ventricle) by the same route as for pituitary tumour

Cerebellar decompression with removal of the posterior arch of the atlas and axis in cases in which the foramen magnum is occupied by the cerebellar tonsils. These cases mostly occur when spinal meningocœle is present This peculiar pressure cone produces the Arnold-Chiari syndrome



A B

FIG. 424

A and B, two views of a baby with hydrocephalus.

Another procedure is to coagulate the genu of the choroid plexus through a ventriculoscope hoping to destroy the tela choroidea and so connect the ventricle to the cisterna ambiens.

Heile's operation consists in anastomosing the pelvis of the kidney to the spinal theca after nephrectomy thus permitting drainage of the cerebrospinal fluid into the bladder (communicating hydrocephalus)

Tracy Putman's suggestion is to diathermise the choroid plexuses through a trephine hole over the convexity of the brain using the ventriculoscope—an instrument somewhat resembling the cystoscope

Torkildsen's operation consists in introducing a plastic polythene tube into the lateral ventricle and carrying the tube down and fixing the other end in position in the cisterna magna by anchoring stitches to the dura This operation is excellent when the hydrocephalus is due to (1) stenosis of the Sylvius aqueduct (2) Rathke pouch dermoids occluding the third ventricle (3) pineal tumours

A DICKSON WRIGHT
R M HANDFIELD-JONES

INTRACRANIAL TUMOURS

The classical triad of headache vomiting and papillœdema are produced by increase of intracranial pressure either from the mass of the tumour and its surrounding œdema or from hydrocephalus in which latter case the growth interferes with the fluid pathways in the 3rd or 4th ventricles To this triad must be added epilepsy generalised or local which is the initial symptom in a large number of cerebral tumours and even occasionally in cerebellar neoplasms Change of personality and loss of vision of any type should also be regarded as possible indications of tumour In children the head is enlarged and gives a cracked pot sound on tapping (MacEwen s sign)

Methods of Localisation—*A* **Clinical Signs.**—1 Above the tentorium these are generally produced by interference with (*a*) the motor or sensory cortex shown as hemiplegia or hemianæsthesia and (*b*) the visual cortex or optic radiation shown as homonymous hemianopia when the whole radiation is affected or a quadrantic homonymous defect when only a portion is affected as occurs for example in tumours of the temporal lobe Involvement of speech or writing centres is also of value Epileptic seizures of Jacksonian type may indicate a localisation in the motor cortex, while uncinate fits with aura of smell suggest temporal lobe growths. Incontinence points to frontal tumour as do mental deteriorations such as Witzelsucht (inordinate grinning) or Seelenlahmung (loss of culture) Anosmia is a sign of frontal lobe tumours and may affect one or both sides according to the involvement of the olfactory nerves

2 Below the tentorium there are special signs which in vermis tumours may be absent even in advanced cases. *Vertigo* and *ataxia* are common signs the latter is sometimes shown in the hands by an inability to perform rhythmical co-ordinated movements (*dys-diadokokinesis*) Involvement of any of the cranial nerves from Vth to XIIth also points to posterior fossa tumour

B **X ray Indications.**—*General Signs* of tumour are those of increased intracranial pressure namely atrophy of the posterior clinoid processes (Fig 479 2) increase of the indentations of the inner table produced by the convolutions (copper beaten skull or convolutional atrophy) and in children, spreading of the sutures and even increase in size of the *foramen* magnum. The shadow thrown by pineal calcification visible after the age of 30 years may be shifted to one side or other by the presence of a tumour

Localising Signs are of great importance and are likely to pass unobserved unless specially looked for —

1 Erosion rarefaction or hyperostosis of overlying bone
2 Increased vascularity of bone due to the nutrient meningeal vessels of the tumour
3 Calcification in the tumour or its pedicle
4 Enlargement of optic foramen in chiasmal tumours
5 Enlargement of internal auditory meatus in acoustic tumours

Ventriculography devised by Dandy is of the greatest value in the localisation of tumours and although it has a definite mortality

rate thousands of lives have been saved by its help in the accurate planning of operations Air is introduced into the ventricles through burr holes made 4 cm to each side of the midline on a line 10 cm above the external occipital tuberosity After opening the dura a blunt needle on each side is passed between blood vessels in the direction of the inner canthus of the eye and at a depth of about 7 5 cm. the body of the ventricle is entered The patient s head is then turned on one side and the fluid flows from the bottom needle air entering the upper one When the ventricles are empty the needles are removed the wound closed and X rays taken from the dilatations and deformities of the ventricles the localisation is made When the lumbar puncture pressure is not high air can be introduced through the needle (encephalography) and frequently good ventricular pictures are obtained by this much simpler method.

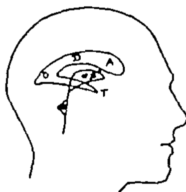


Fig 423

Diagram showing approximate shapes of ventricles. A, D, O T the lateral ventricle (cap of liberty). B, third ventricle (Napoleon hat), the dot in the centre of which is the middle commissure C, the fourth ventricle (boy scout hat)

The ventricular pattern in normal cases is very constant The side-view can be well memorised by regarding the lateral ventricles as shaped like an attenuated cap of liberty enclosing Napoleon s hat (3rd ventricle) complete with its cockade (middle commissure) and hanging on from the 3rd ventricle a boy scout s hat (the 4th ventricle) (Fig 423) The anterior horns are filled when the patient lies on his back and the occipital horns when lying on his face In the normal anterior view the ventricular outline resembles a headless butterfly the upper wings are the bodies of the lateral ventricle and the lower ones the frontal horns and the body of the butterfly is the 3rd ventricle

Arteriography is another method of localising aneurysms and tumours of the brain 15 c c of Diodone 30 per cent are injected rapidly into the common carotid artery exposed under local anaesthesia and as the injection is finishing a picture is taken which shows the arteries and two seconds later another shows the cerebral veins. Injection of the vertebral artery has also been done for lesions or the cerebellum The position of the tumour is determined by the displacements of the main blood vessels or by visualisation of the blood supply of the tumour itself Filling of an aneurysmal cavity or arteriovenous communication will also give an accurate diagnosis of these conditions (Fig 426) The intra arterial injection of the opaque media is often done now without exposure of the artery

Electro-encephalography is the latest method of localising brain lesions especially tumours The minute action currents of the brain are rendered visible by cathode ray apparatus the amplitude of the waves being increased and their periodicity reduced when the electrode lies over a lesion

A



B

Fig. 425

A, arteriogram showing aneurysm of circle of Willis. B, aneurysm remains filled. This case was successfully treated by ligature of the internal carotid artery

Intracranial tumours of which over 50 per cent are benign provide the bulk of all surgical work of the head. As in few other parts of the body do benign growths preponderate to such a degree the results of this type of surgery are very satisfactory It is clear however that exact localisation is all important

TUMOURS OF THE BASE OF THE BRAIN

Comparatively easy is the diagnosis of many of these growths because they produce such definite syndromes owing to their proximity to the cranial nerves The *First Group* consists of tumours in the neighbourhood of the optic nerves These are —

1 Pituitary adenomata—with eosinophil, basophil or neutrophil cells.
2 Suprasellar cysts
3 Suprasellar meningiomata.
4 Gliomata of the optic chiasma.

Pituitary Tumours (Fig 427) betray their presence by their endocrine effects and by the pressure they exert upon the optic nerves The visual field changes are characteristic being due to chiasmal pressure The decussating fibres from the nasal halves suffer and so the temporal fields are lost at first (bi temporal hemianopia) but later complete blindness may result and once optic atrophy has supervened all hope of recovery of sight is gone These pituitary tumours are of the following types —



Fig. 427
A pituitary tumour

(*a*) Chromophil adenoma, causing gigantism or acromegaly often optic nerve changes and sometimes a peculiar cachexia after many years
(*b*) Basophil adenoma causing the syndrome of Cushing—high blood pressure cyanosis hirsuties and adiposity This disease is generally fatal before the adenoma reaches any size or causes nerve pressure It may be ameliorated by implanting radon seeds in the pituitary fossa.
(*c*) Chromophobe adenoma showing marked optic nerve pressure and less noticeable endocrine changes It is often cystic. The endocrine changes are those of pituitary inadequacy viz amenorrhoea impotence diabetes insipidus etc and are due to the pressure of the adenoma on the functioning gland

Congenital Cysts in the Suprasellar Region arise in the pharyngeal diverticulum from which the pituitary develops These cysts are best known in children but they may not produce symptoms till even

as late as 70 years They are multiloculated and generally have a solid root of characteristic adamantinoma cells In children they often cause signs of pituitary inadequacy (Fröhlich s fat type or Lorain s infantile type) The visual field changes though often bitemporal are sometimes very irregular These cysts at times press to such an extent on the floor of the 3rd ventricle that hydrocephalus and papillœdema follow

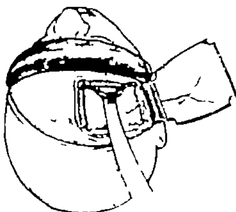
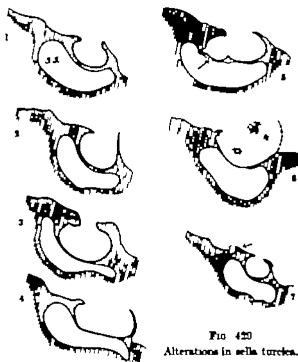


FIG. 428
Exposure of pituitary region. Incision f dura along line of sphenoidal wing not shown.

Prognosis —Operations for pituitary tumour have the lowest mortality of all intracranial procedure which is as it should be since they are usually performed only to save sight and not life The dangerous cases are those in which there is a large extension of the growth into the mid brain or frontal lobes

Treatment —These tumours are now always exposed through the transfrontal approach preferably on the right side (Fig 428) The tumour is then incised between the optic nerves and its contents emptied if cystic or sucked and curetted if solid After collapse of the neoplasm its wall can often be removed as there are only feeble attachments to surrounding vessels If the capsule of an adenoma must be left behind it is a good practice to place a small pledget of wool soaked



1, normal sella; 2, atrophy of posterior clinoid process through increased intra cranial pressure from any cause; 3, chromophil adenoma, acromegalic thickening of clinoid processes delays extension of adenoma upwards; 4, chromophobe adenoma quickly bursts out of the sella; 5, Gourd sella of glioma of optic chiasma; 6, suprasellar cyst, diffuse calcification in solid part of tumour and comet tail in wall of cyst 7 small hyperostosis mark root f meningioma growing from anterior clinoid process.

FIG 429
Alterations in sella turcica.

Intracranial tumours of which over 50 per cent are benign provide the bulk of all surgical work of the head. As in few other parts of the body do benign growths preponderate to such a degree the results of this type of surgery are very satisfactory It is clear however that exact localisation is all important

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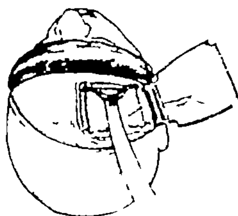


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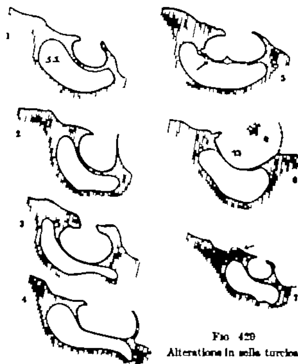


FIG 429

Alterations in sella turcica.

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in Zenker s solution inside it at the end of the operation for two minutes any remaining adenomatous tissue is destroyed by this powerful fixative

Suprasellar Meningioma produces a bi temporal hemianopia without signs of endocrine dysfunction or enlargement of the sella turcica They declare themselves so early in their career that they are generally small and easily removed Since they are benign they have a low mortality rate and do not recur if completely removed unfortunately many are not diagnosed till the sight is destroyed

Glioma of the Optic Chiasma gives a syndrome of progressive blindness with optic atrophy and sometimes appearance of a tumour on the optic disc The glioma can be dissected from the substance of the nerve but a good deal of the sight is usually lost Apart from the

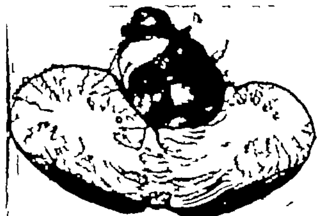


Fig. 430

Auditory nerve tumour

different clinical syndromes of tumours adjacent to the chiasma the separation of the various types can be made from characteristic X ray changes in the region of the sella (Fig 429)

The Second Group includes growths in the neighbourhood of the olfactory groove corpora quadrigemina and auditory nerve

Olfactory Groove Meningiomata grow to a very large size before declaring themselves because they grow upwards into the silent regions of the frontal lobes They often produce the characteristic Foster Kennedy syndrome of optic atrophy on the affected side and papilloedema on the other Anosmia on one or both sides is of course a constant feature of these tumours A wide exposure is necessary for their removal as they often reach a gigantic size

Tumours in the Neighbourhood of the Corpora Quadrigemina produce changes in eye movements inability to look upwards and ptosis being the main signs Pineal growths form the main bulk of these cases and occur as either tumours of the pineal cells cholesteatomata or true dermoid cysts

Auditory Nerve Tumour (acoustic neuroma) (Fig 430) produces a very clear-cut syndrome Firstly there are the general signs of a

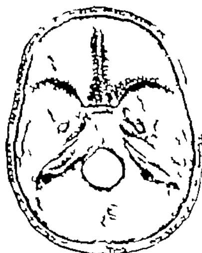
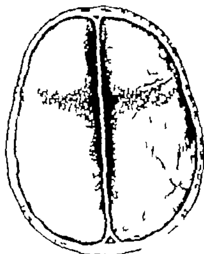
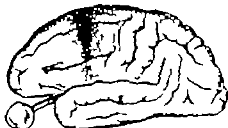
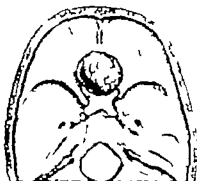
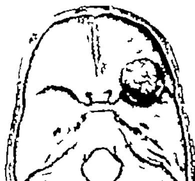




Fig. 431
Favourite regions for meningiomata, other sites being very uncommon.





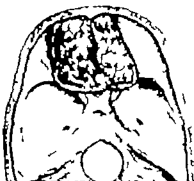



Fig. 432
Classical types of meningioma.

1 suprasellar; 2, sphenoidal ridge (note how the tumour riding horseback on the sphenoidal ridge involves both anterior and middle fossæ); 3, olfactory groove.

cerebellar tumour (ataxia drunken gait vertigo etc) and secondly the localising nerve signs on the affected side (nerve deafness facial palsy of lower motor neurone type and facial anaesthesia) The combined involvement of the last two nerves causes the corneal reflex to be lost early on the affected side The skin papillomata and pigmentation of von Recklinghausen's disease are sometimes associated with acoustic neuroma The age incidence is from 25 to 50 years and it is interesting that the majority of cases are female

TUMOURS OF THE MENINGES

Meningiomata constitute about 15 per cent of cerebral tumours and being benign they provide the greatest successes of brain surgery They derive as a rule from the dura and show a characteristic histology of whorls and columns of endothelial cells with frequent changes such as myxomatous fatty and calcareous degenerations. The word psammoma is used to indicate a meningioma in which

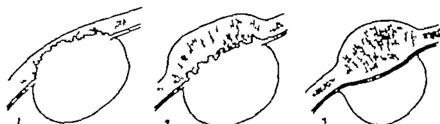


FIG. 433
Alterations in bone over a meningioma.
1, erosion ; 2, erosion and hyperostosis ; 3, hyperostosis due to invasion of bone.

much calcification has taken place Meningiomata probably originate from arachnoid villi and cell clusters and therefore have a corresponding localisation as shown in Fig 431 It will be seen that they follow a roughly cruciate distribution, both on base and vertex well known types being olfactory groove suprasellar sphenoidal ridge and parasagittal meningiomata (Fig 432)

These tumours reveal themselves sometimes in plain X-ray pictures of the skull by increased vascularisation of the adjoining bone calcification of the pedicle of the tumour and various secondary changes in the overlying bone such as rarefaction erosion, hyperostosis or combinations of these (Fig 433)

In the absence of these characteristic X ray changes the presence of a meningioma can often be anticipated from the slow march of symptoms and also from the frequent association of epilepsy with these tumours Operative removal is as a rule straightforward, but is sometimes rendered dangerous by their great vascularity and situation and one or more blood transfusions may be necessary during the operation Injury of large important vessels adjoining the tumour may cause a fatality as in suprasellar and sphenoidal ridge types Certain of the tumours grow *en plaque* and are hard to remove completely Fortunately this type is often very sensitive to X ray therapy

TUMOURS OF THE BRAIN

Gliomata are not uniformly malignant tumours Careful patho logical classification has resulted in four main groups being describe These with their favourite sites of occurrence are —

1 Medulloblastoma vermis of cerebellum of young children
2 Spongioblastoma multiforme hemispheres of adults from 30 t 50 years
3 Oligodendroglioma frontal lobes of young men and wome (calcification frequent)
4 Astrocytoma vermis of cerebellum of children and hemispher of adults from 30 to 50 years

Other varieties of gliomata have been described but these are th main types and they only will be described.

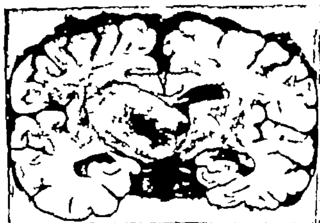


FIG 434
Spongioblastoma multiforme.

MEDULLOBLASTOMA is a very cellular highly malignant tumour quite young children. The growth either wholly or in part is remov through a vertical incision in the vermis and radium or X ray thera is applied through the occipital decompression opening after the wou is soundly healed. Response is prompt but unfortunately recurrence rapid and most cases are dead within two years This tumour notable as being the only one metastasising through the cerebrospi fluid and producing secondary growths of the spinal cord

SPONGIOBLASTOMA MULTIFORME (Fig 434) is an intensely malign rapidly growing tumour against which no surgery or radio-thera avails. The present custom is not to operate when biopsy by br needling reveals this tumour If at operation this typical diff hæmorrhagic multicystic tumour is found, it is customary to remo all the tumour possible and then sew up tightly without a decompressi so that the patient will keep well for a few months and then die rapid thereby the miserable degringolade associated with decompression avoided Rarely a lobectomy will accomplish a complete removal this growth when it occurs in the frontal temporal or occipital lob

Oligodendroglioma is a less common tumour which often lends itself to complete removal of the frontal lobe a condition not incompatible with normal existence and intelligence even when the left lobe is ablated

Astrocytoma is to a great extent a midline cerebellar tumour of young children. It shows clear demarcation and frequently has an associated cyst Removal is not followed by recurrence and the results are good The astrocytoma of the hemispheres of adults is not so clearly encapsuled and the operative results are correspondingly worse.

VASCULAR AND OTHER TUMOURS

Angiomata are a small group and vary from huge racemose arterio-venous aneurysms through compact highly vascular tumours to small growths in the walls of large cysts These latter occur usually in the cerebellum and, when associated with retinal angiomata and a cystic pancreas produce the syndrome known as Lindau's disease The treatment of these tumours is often difficult because of their vascularity but the compact and cystic varieties can be satisfactorily removed Large arterio-venous aneurysms are best treated by excision with systematic hæmostasis

Cerebral Aneurysms are generally due to congenital defects in the arterial wall (Fig 420) They are usually basal in association with the circle of Willis and produce characteristic pressure effects on the cranial nerves These often appear suddenly because of leakage and when in the anterior part of the circle cause sudden complete ophthalmoplegia and facial pain (ophthalmoplegic migraine) when posterior facial paralysis and deafness may appear

The anterior aneurysms are well treated by carotid ligation. The posterior ones have been occasionally cured by opening them and stuffing the cavity with a muscle graft

Tumours of the Choroid Plexuses are either colloid cysts or papillomata Cases do well after removal of these lesions

Ependymomata are tumours growing from the lining of the ventricles The commonest type grows in the 4th ventricle and gives symptoms of cerebellar tumour A large tail sometimes hangs through the foramen magnum, and thus the signs may be those of a spinal tumour They are benign and of remarkably slow growth.

Cholesteatomata, pearly tumours or epidermoids result from inclusion of an area of skin epithelium in the brain during embryonic development Down the years of life the desquamation of the skin lining slowly expands the tumour till symptoms are produced If accessible their operative treatment is very satisfactory The contents are scraped out and the cyst lining removed The favourite site is the temporal lobe and the midline in the neighbourhood of the pineal gland or the vermis

Surgical Technique for Intracranial Operations

Intracranial operations in earlier days were conducted at incredible speed and the blood which was shed profusely was washed away with a constant stream of saline playing over the wound It is now realised that

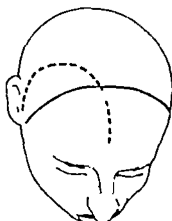


Fig. 435
Alternative incisions for frontal and pituitary operations.

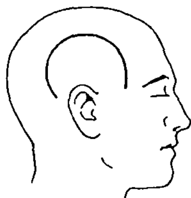


Fig. 436
Incision for temporal tumours. For parietal growths the incision is placed a little higher.

Fig. 437
Removal of meningioma by combination of traction and cotton-wool strips between the tumour and surrounding brain.

speed is not essential and in most quarters, has given way to a more deliberate technique with conservation of blood and brain tissue

SUPRATENTORIAL OPERATIONS —The scalp is incised according to the situation of the tumour In frontal and pituitary tumours the incisions used are shown in Fig 435 and the scalp is turned down before the bone is drilled whereas in parietal and occipital lesions (Fig 436) the bone is turned down with the scalp flap The skin incision is made with pressure applied on each side of the wound and the galea is seized with forceps before the pressure is released, so that when those forceps are angled back over the cut edge all oozing is checked The pericranium is then incised with the diathermy needle and the periosteum pushed back so as to make room for the burr holes which are generally five in number and made with an electric or hand burr These holes completed, a Demartel's guide is passed from one to the next followed by a Stille s modification of Gigli's saw the holes are then joined up The bone flap is next broken back on its temporal muscle attach ment and the dura ex posed The large dural vessels are tied with silk stitches and smaller bleed ing points controlled by touches with the dia thermy If the brain *pressure is very high* it should now be reduced by inserting a brain needle into the ventricle or the cyst so often associated with tumours, when by withdrawal of fluid the pressure is so reduced that the dura can be safely opened without brain herniation. Sometimes fluid cannot be found and the opening of the dura i fraught with danger of damage to the brain cortex It may be necessary to inject intravenou ly 100 c c of 15 per cent sodium chloride in such a case and wait half an hour before rapidly inci ing the dura

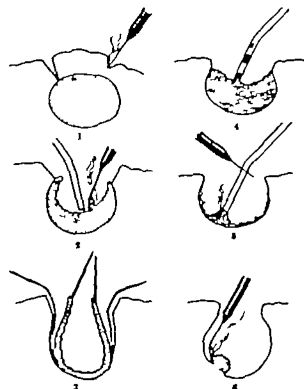


FIG. 439

Methods of removing cerebral tumours.

1 uncapping it — scalloping it out with cutting diathermy loop; 3, removing capsule by traction and cotton wool dissection 4, sucking out the soft tumour; 5 coagulating the vascular net ork, using metal sucker t be; 6, x sing mural nodule from the cyst

Once the cortex is exposed the tumour may be seen or its presence inferred by the flattened convolutions overlying it If seen it is separated by gentle dissection with cotton pledgets from the surrounding brain and by traction with silk stitches inserted through the tumour itself is gently dislodged from its bed (Fig 437) If the tumour is sub-cortical its relations are ascertained by inserting a brain needle at several sites and then " uncapping the tumour by excising a medallion of cortex over it (Fig 438).

Bleeding from the cortex is prevented by putting silk ligatures around or silver clips on the larger vessels and coagulating a track in the cortex before incising with the diathermy needle The tumour is then removed by gentle cotton-wool dissection It sometimes happens that the tumour is too large to be removed *in toto* in these cases the centre of the tumour is cored out with the diathermy cutting loop or sucked out and the remaining shell can then be withdrawn from the surrounding brain

After removal of the tumour the bed is systemically hæmostased The

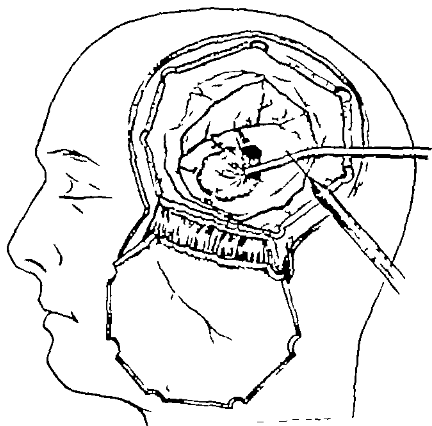


FIG. 430

Method of exposing temporal lobe tumour which has been removed with a metal sucker and vessels coagulated from time t time.

vessels are picked up with dissecting forceps and sealed with the coagulation current. Silver artery clips may also be used, and a neat way of securing difficult vessels is shown in Fig 430 the vessels being drawn into the mouth of a metal suction tube and coagulated with the diathermy current Muscle fibrin or gel foam can also be used for stopping difficult vessels. When all is dry the flap is returned to place and fixed with a silver wire the muscle and galea are then sutured with fine waterproofed silk and the skin closed with silkworm gut stitches. Twenty four to seventy two hours drainage may be used into a large tumour cavity or under an extensive flap.

After-treatment—The skin stitches are cut in forty-eight hours and removed in seventy two hours the wound does not gape because of the careful silk suturing of the galea aponeurotica Post-operative increase of

intracranial pressure can be dealt with by ventricular or lumbar punctures and the administration of hypertonic solutions. Progressive post-operative compression should be met by reopening the flap and removal of the fresh blood clot, the wound being reclosed meticulously and a small drain left in.

It is sometimes necessary to be discreet and stop the operation before complete removal of a tumour owing to blood loss or shock. In such a case the closure has to be most carefully made because pressure still exists and herniation would be a disaster as would even the mildest wound sepsis because of the danger of a subsequent operation in the presence of infection

CEREBELLAR OPERATIONS.—The cerebellum is exposed by a curved incision (Fig 440) in adults and a straight vertical incision in children. The muscles are stripped off the occipital bones with diathermy and raspatory and the emissary veins plugged with wax. The bone is then drilled and nibbled away the posterior margin of the foramen magnum and the occipital bones being removed until the lateral sinus is exposed The posterior border of the atlas and even axis must also be excised if the cerebellum has been forced as a pressure cone through the foramen magnum In acoustic neuroma the removal of bone is done only on one side The dura is now incised by a number of radiating incisions but before doing this pressure should be reduced by emptying the lateral ventricles the cisterna magna and the cyst if this is present.

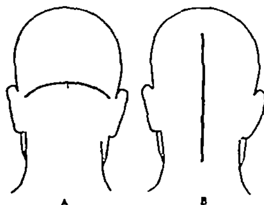


FIG. 440

Incisions for cerebellar operations.

A, for adults—dotted line incision is optional to gain access to upper vertebræ; B, for children.

When the cerebellum is exposed the tumour is attacked, if it can be seen. It is sometimes necessary to incise the vermis or cerebellar lobe to expose the tumour which is then removed as previously described. If a cyst is found, its wall is carefully examined and in one place a nodule will be found. This mural nodule " if carefully removed will prevent the recurrence of the cyst, since it is the tumour itself an angioma or astrocytoma as a rule (Fig 441)

After cerebellar operations increase of pressure may be very troublesome and sometimes œdema of the medulla occurs because of the operative disturbance These complications can be guarded against to some extent by leaving a small catheter in the lateral ventricle for three to four days and by being careful to remove enough bone from the atlas, and even axis, to give freedom from pressure

THIRD VENTRICLE OPERATIONS are now frequently performed, the great precision of ventriculography enabling tumours here to be diagnosed. When they lie in the anterior part of the ventricle exposure is made by excising a medallion of cortex from the right frontal lobe and widely opening the lateral ventricle when by enlarging the foramen of Monro the tumour can be removed The common growth in this anterior situation is the colloid cyst arising from the choroid plexus It is a benign lesion and its removal effects a complete cure The tumours in the posterior part of the ventricle are exposed by a right-sided occipital flap the right occipital lobe is retracted outwards after emptying the ventricular fluid by needle The

tentorium and the splenium are now incised and the tumour exposed Most neoplasms in this region derive from the pineal body and are very malignant, but an occasional embryonic tumour in this situation makes exploration worth while The high death rate from these operations in the pineal region has led to more use of the Torkildsen operation combined with radiotherapy

Operations upon the Cranial Nerves —The optic nerves and chiasma are often surrounded by adhesions the result of trauma syphilis or adjacent sphenoiditis or ethmoiditis. This important disease (chiasmal arachnoiditis)

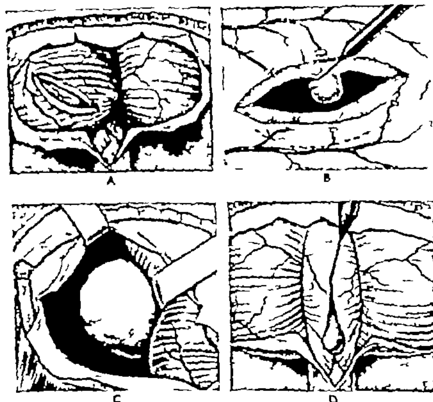


Fig 441

Methods of approach to cerebellar tumours.

A, cerebellum freely excised t xpose the tumour in one lobe ; B, the removal of mural nodule with diathermy ; C, exposure of tumour in cerebello-pontine angle. Removal of fluid from ventricles and basal cisterns gives the necessary room ; D, incision of expanded vermis to expose mid-line tumour

is often overlooked and complete blindness may supervene generally with the diagnosis of retrobulbar neuritis. The arachnoiditis may take the form of fibrous bands, soft granulation tissue cystic collections or dense encapsulating fibrous tissue Careful stripping of the nerves from this tissue produces most gratifying results.

The Trigeminal Nerve the seat of the common complaint of tic douloureux most frequently requires operation. The injection of the nerve with alcohol is still a favoured procedure although in many quarters it is felt that the division of the sensory route behind the ganglion is a more precise operation.

Alcohol Injection is best done by Hartel's route A long needle is entered 2 cm outside the angle of the mouth pointing towards the lambda

The *Auditory* nerve is now frequently divided for Ménière's disease (paroxysmal aural vertigo) The nerve is divided on the side on which tinnitus and hearing are worst by the same cerebellar route as for the Vth nerve If the hearing is not much impaired the vestibular (anterior) half of the nerve is divided leaving the cochlear half intact

The *Glossopharyngeal* nerve is sometimes divided by the cerebellar route for neuralgia of this nerve It is also a very great help to divide this nerve together with the Vth in cases of severe pain in carcinoma of tongue and fauces

HERNIA CEREBRI

This term should not be applied to those protrusions of brain matter through a deliberately planned decompression opening in which case the scalp is intact over the swelling Hernia cerebri implies the prolapse of brain substance through an opening in both skull and scalp the actual visible tissue consisting of inflamed cerebral matter Such a condition must inevitably be an indication of increased intra cranial tension, for if this was absent the inflammation of the prolapsed tissue would subside and the brain retire within the skull It occurs as a result of penetrating injuries which have infected the skull as well as the brain, in which case the prolapsed tissue is largely composed of exuberant granulations rather than the brain itself. It will also be seen as a late result of formal decompressions when either the suture line yields to increasing pressure or the skin is involved in the spread of the growth.

Treatment must be directed towards the underlying increased intracranial tension In those cases in which sepsis is the main etiological factor the surface should be treated with dehydrating dressings such as absolute alcohol hypertonic saline or glycerin and magnesium sulphate paste These patients are likely to suffer from various forms of epilepsy and it may be necessary at a later date to excise the scar free the brain from adhesions and repair the defect in both skull and scalp If the cause of increased intracranial tension is progressive and not amenable to successful removal no *treatment* is of any avail and the hernia must be regarded as a terminal manifestation. Thiersch skin grafts applied to the surface of the fungus take well. The clean epithelialised surface so obtained is a great advantage and permits further operative treatment in a clear field.

A DICKSON WRIGHT

CHAPTER XLII

THE DISEASES OF THE SPINE AND SPINAL CORD

SURGICAL ANATOMY.—The vertebral column consists of seven cervical, twelve dorsal, and five lumbar vertebræ, together with the fused sacral and coccygeal elements below The intervertebral discs of elastic fibrocartilage increase the range of movement of the column as a whole and act as "dampers to the jolts and jars to which the spine may be subjected. A considerable range of flexion and extension is possible as are lateral bending and rotation to a lesser degree In childhood the column presents one slight continuous curve with an anterior concavity in adults this concavity persists in the dorsal region, but in both the cervical and the lumbar portions the curve has been changed so that the concavity faces backwards. The whole spinal column, therefore has an S-shaped curve

Surface Markings.—*The following points have an important application* to clinical examination —

- The cricoid cartilage is at the level of the 6th cervical body
- The spinous processes of the 7th cervical and 1st dorsal are easily palpable
- The root of the spine of the scapula corresponds to the 3rd dorsal spinous process.
- The inferior angle of the scapula (at rest) is opposite the 7th dorsal spine
- The line joining the highest points of the iliac crests crosses the interval between the 3rd and 4th lumbar vertebræ
- The line joining the posterior superior iliac spines passes over the 2nd sacral spine

The spinous processes bear varying relations to their own vertebral bodies according to the amount of slope they possess so that

- All the cervical and 1st 2nd, and 3rd dorsal spines correspond to their own bodies
- The 4th to the 7th dorsal spines are opposite the bodies of the vertebra next below
- The 8th to the 12th dorsal spines are at the level of the lower border of the vertebra next below
- All the lumbar spines are opposite their own bodies.

The spinal cord lies within the vertebral canal and is enclosed in a prolongation of the three membranes which surround the brain Their relative arrangement is exactly similar and the subarachnoid space is likewise filled with cerebrospinal fluid The dura mater ends at the level of the upper border of the 3rd sacral segment whereas the spinal cord terminates at the level of the intervertebral disc between the 1st and 2nd lumbar vertebræ below which level the nerve trunks of the cauda equina occupy the spinal canal

Physiologically the spinal cord retains its developmental arrangement and is consequently composed of a number of segments, from each of which

arise a pair of spinal nerves. These nerves, having both anterior and posterior roots, leave the bony canal through the intervertebral foramina, but since the spinal cord is so much shorter than the vertebral column it must necessarily follow that the nerves run downwards in the canal before reaching their appropriate openings further this obliquity of their course increases as the cord passes downwards, until eventually the 3rd 4th and 5th lumbar and all the sacral segments are collected together in the conus medullaris, which corresponds in level to the 11th and 12th dorsal and 1st and 2nd lumbar vertebræ

The surface markings of the various spinal segments may be given somewhat roughly as follows —

In the cervical region add one to the number of the vertebra for each cervical segment

In the upper six dorsal add two

In the lower six dorsal add three to the number of the vertebra concerned

Development —The spinal cord is developed very early from a median longitudinal groove in the dorsum of the embryo This epiblastic groove deepens and on either side of it appear lateral ridges of mesoblast and epiblast. The neural groove becomes buried beneath the surface by the fusion of the lateral ridges. It is represented by the central canal of the cord, which is formed from the epiblastic inclusion while the laminæ spinous processes and post vertebral muscles are developed in the mesoblast of the lateral ridges

CONGENITAL ANOMALIES

Spina Bifida

Spina bifida as its name implies is a developmental defect in which the spinous processes have not been formed owing to the failure of the laminæ to meet and fuse in the midline behind. This bony defect may or may not be accompanied by anomalies of development of varying degrees in the spinal cord It occurs chiefly in the lumbar region but is occasionally present in the cervical part of the column and with the exception of spina bifida occulta all varieties are recognised at birth In many infants there will be associated congenital anomalies some the direct result of the spinal cord lesion such as paralytic talipes equinovarus others unconnected with it *e.g* cleft palate imperforate anus etc

The *etiology* is unknown though in a few instances a familial tendency exists There appears to be a connection between it and hydrocephalus for not only do the two conditions coexist but the successful closure of a meningocele may be ruined some months later by the development of an internal hydrocephalus

Varieties of Spina Bifida (Fig 444) —

A **Spina Bifida Occulta** is the only variety in which there is no external swelling and which frequently is not recognised until the second or third decade of life The failure of closure of the laminæ is present but there is no gross involvement of the cord or of its membranes On the surface some patients will show a revealing sign such as a pilonidal sinus nævus subcutaneous lipoma or hairy mole The posterior surface of the spinal membranes may be

Treatment.—Meningoceles and meningomyeloceles (with spinal nerves and not the whole cord) are alone amenable to surgical treatment and then only if the skin is healthy The sac is excised, the nerve elements replaced the dura closed, a muscle flap turned across the gap and the skin sutured Even when the result seems good at first a secondary hydrocephalus is likely to develop within a few months

Tumours of the Sacrococcygeal Region

A number of very rare tumours are met with in this area arising either from the neurenteric canal or the post-anal gut They include the sacral pilonidal sinus the post-anal dimple dermoid cysts and lipomata Certain specialised tumours of great pathological but slight



Fig 447

A sacrococcygeal tumour Mr V Pennell's case.

surgical interest are the chordoma and the congenital sacrococcygeal tumour the former arises in the remnant of the notochord while the latter is a true teratoma being regarded by some observers as an example of an included fœtus (Fig 447)

Pilonidal Sinus requires special description It consists of a sinus lined by squamous epithelium leading down to the periosteum on the posterior aspect of the sacrum Its surface opening is almost always in the middle line in the deep skin groove between the buttocks and at any level between the 1st sacral spine and the coccyx There seems to be no real reason why so trivial a developmental anomaly should become a surgical problem It does so however because of its liability to infection This in itself would not appear a serious matter but frequently such infection is imperfectly resolved in the first occasion and a spreading cellulitis may lead to one or more sinuses in either buttock. The resulting condition may prove resistant to all but the most radical extirpation In such cases the whole track with its ramifications must be laid open and the more severe examples will need to be left widely open and allowed to granulate from the base Earlier and less extensive cases must be fully excised and in the final suture care must be taken to leave no dead space beneath the skin

INJURIES OF THE SPINAL CORD

Fractures fracture-dislocations and other injuries of the vertebral column are described in full in Chap XLVI and here we are concerned only with those lesions of the spinal cord and cauda equina

which result from injury A perfect understanding of the clinical pictures produced by injury and disease of the spinal cord at various levels can be founded only on an exact knowledge of the anatomy and neurophysiology of the central nervous system The student is therefore referred to the standard textbooks on these subjects he will find that he is amply repaid for the time thus spent because he will then appreciate that the clinical picture of all spinal cord lesions is governed exclusively by an anatomical and physiological exactitude

Concussion of the Spinal Cord

The physical conditions of environment of the brain and spinal cord are so different that no useful purpose is served by attempting comparisons between them The brain is encased within the unyielding skull and is subject to variations of intracranial pressure whereas no such conditions are present in the vertebral canal

The pathology of spinal concussion is therefore different to that of the brain and its occurrence is altogether denied by some neurologists Nevertheless a condition does occur though very rarely in which widespread loss of function follows an injury to the spinal column complete recovery taking place within thirty-six hours It is believed that the only pathological changes present in the cord are minute areas of hæmorrhage and œdema.

The Clinical Picture varies according to the site and severity of the injury Usually there is a total cessation of all functions of the cord below the affected segment combined with an advanced degree of general shock In the upper cervical region death may be instantaneous in the lower cervical segments all four limbs are paralysed while lower down still the damage is confined to the lower limbs and the sphincters of the bowel and bladder In general even when motor loss is complete sensation is rarely entirely interrupted and priapism never occurs In severe cases the picture is that of a complete transverse lesion of the cord while partial injury to this structure may be made to appear more extensive than it actually is by the concussion which accompanies it

Diagnosis and Treatment—It is evident that in the early hours after injury an exact diagnosis is impossible and no one can say whether a total transverse lesion or concussion alone is present. The early treatment therefore must be that of a total lesion, the patient being kept absolutely prone and most carefully nursed Within forty eight hours either complete recovery has taken place or the residual loss of motor and sensory function will define the extent of the gross injury

Compression of the Spinal Cord

Although injuries to the spinal cord are usually of sudden and dramatic onset and their results both formidable and far reaching it must not be thought that every injury will produce extensive muscular paralysis sphincter dysfunction and sensory loss Further more the spinal cord and its nerves are damaged more gradually and

more insidiously by other agents than gross trauma. Before describing the grave lesions of the spinal cord associated with injuries of the vertebral column, it will be instructive to obtain a general clinical picture of the results both of gradual compression and also of sudden gross destruction of nerve tissue. The effects on the nerves the cord itself and the circulation of the cerebrospinal fluid must be considered separately

A **The Spinal Nerves.**—A mild degree of pressure on the *posterior nerve roots* causes irritative symptoms in the peripheral distribution of the nerve Sensations of tingling pricking and pins and needles will be followed by pain and hyperaesthesia of the skin supplied by the nerve Later when pressure becomes sufficient to arrest all conduction of nerve impulses anaesthesia takes the place of hyperaesthesia but the pain continues (anaesthesia dolorosa) Pressure on the *anterior roots* is rarely seen except in conjunction with other and more extensive lesions In its early stages it leads to spasmodic twitchings and cramps which will later be succeeded by muscular atrophy flaccid paralysis and loss of deep reflexes Pressure on the *spinal nerve trunk* as it traverses the intervertebral foramen will provide a picture of combined motor and sensory irritation in the early stages and paralysis and anaesthesia in the later all of which are confined to the area of distribution of the nerve concerned

B **The Spinal Cord.**—1 *Gradual Compression* —(*a*) Motor effects The earliest signs will be a weakness of voluntary movement in the toes and feet succeeded by a gradual development of spastic paraplegia with increased reflexes and the presence of an extensor plantar response and ankle clonus In the next stage the flexor group of muscles atrophy more quickly than the extensors the legs become still weaker and paraplegia in extension is established Eventually all power of voluntary movement is lost and the joints of the lower limb are pulled into extreme flexion with the thighs in contact with the abdominal wall— paraplegia in flexion.

(*b*) Sensory changes At the level of the compression pain is experienced in the distribution of the spinal segment actually compressed These root pains often precede all other symptoms by many weeks and are of the greatest diagnostic importance as giving a clue to the level of the lesion Below this a loss of sensation gradually appears simultaneously with the early muscle weakness until finally a complete anaesthesia up to the segmental level of the compression is established In the area of distribution of the segment immediately above that affected a zone of hyperaesthesia may be interposed between the areas of normal and abolished sensation.

(*c*) Sphincter Control In the early stages there will be bladder irritability and some loss of control Later the behaviour of both bladder and rectal sphincters depends on the level of the lesion If this is above the centres in the lumbar segments of the cord there will be retention of urine which passes into the condition of retention with overflow until eventually the bladder adapts itself to an involuntary emptying at definite periods over which the patient has no control—

the automatic bladder There is constipation combined with loss of control after the administration of aperients

When the lesion is low down in the cord true incontinence of both urine and fæces occurs

(d) Trophic changes are marked in the area below the level of the lesion and it may be impossible in spite of the most skilful and loyal nursing to prevent the occurrence of bed-sores

2 *Sudden Compression* is accompanied by the immediate onset of total flaccid paralysis with complete sensory loss below the affected level If the patient survives the shock there will be retention of urine constipation priapism and trophic changes The picture varies with the level of the lesion and will be described below

C **The Cerebrospinal Fluid.**—Should the subarachnoid space be occluded the cerebrospinal fluid becomes stagnant and certain changes occur in it These constitute Froin s syndrome the fluid being yellow in colour having a specific gravity far in excess of normal and coagulating spontaneously on standing

Methods of Examination—A searching neurological investigation will go far to establish both the diagnosis and the level of the lesion but it is not always possible to be sure on clinical grounds alone Froin s syndrome and Queckenstedt s test confirm the presence or absence of a block to the circulation of the cerebrospinal fluid, while the exact level of an obstruction within the theca can be demonstrated by radiology after lipiodol injection The diagnosis and the decision as to operation are so frequently matters of such difficulty that the closest co-operation between neurologist and neuro-surgeon is called for

Spinal Hæmorrhage

Hæmorrhage into the vertebral canal is usually associated with injuries to the spinal cord and column, but occurs very rarely apart from injury in young people below the age of 20 years Every severe injury of this region must be accompanied by intraspinous bleeding but two types of spinal hæmorrhage are described in which the symptoms are due to the hæmorrhage itself and not to gross injuries of the cord or column.

Hæmatorrhachis (Extramedullary Hæmorrhage)—As a result of an injury to the spinal column which gives no signs of fracture or dislocation bleeding may occur either between the dura and the bone or within the dural sac It almost invariably affects the cervical region After an initial period of spinal concussion the picture is that of spinal irritation, with root pain and muscle twitchings Later if sufficient blood is extravasated paralysis and anæsthesia will follow Since the lesion is usually cervical, there is a lower motor neurone type of flaccid paralysis and muscular atrophy in the arms and an upper motor neurone type in the legs with exaggerated reflexes

A completely different picture is seen when the blood trickles down inside the dura and slowly but in increasing amount collects in the lower part of the thecal space This leads to Thorburn s gravitation paraplegia in which first the signs of irritation and then those of

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Hæmorrhage into the vertebral canal is usually associated with injuries to the spinal cord and column, but occurs very rarely apart from injury in young people below the age of 20 years Every severe injury of this region must be accompanied by intraspinous bleeding but two types of spinal hæmorrhage are described in which the symptoms are due to the hæmorrhage itself and not to gross injuries of the cord or column

Hæmatorrhachis (Extramedullary Hæmorrhage)—As a result of an injury to the spinal column which gives no signs of fracture or dislocation bleeding may occur either between the dura and the bone or within the dural sac It almost invariably affects the cervical region After an initial period of spinal concussion the picture is that of spinal irritation, with root pain and muscle twitchings *Later* if sufficient blood is extravasated paralysis and anæsthesia will follow Since the lesion is usually cervical there is a lower motor neurone type of flaccid paralysis and muscular atrophy in the arms and an upper motor neurone type in the legs with exaggerated reflexes

A completely different picture is seen when the blood trickles down inside the dura and slowly but in increasing amount collects in the lower part of the thecal space This leads to Thorburn s gravitation paraplegia in which first the signs of irritation and then those of

more insidiously by other agents than gross trauma. Before describing the grave lesions of the spinal cord associated with injuries of the vertebral column it will be instructive to obtain a general clinical picture of the results both of gradual compression and also of sudden gross destruction of nerve tissue The effects on the nerves the cord itself and the circulation of the cerebrospinal fluid must be considered separately

A **The Spinal Nerves.**—A mild degree of pressure on the *posterior nerve roots* causes irritative symptoms in the peripheral distribution of the nerve Sensations of tingling pricking and "pins and needles" will be followed by pain and hyperæsthesia of the skin supplied by the nerve Later when pressure becomes sufficient to arrest all conduction of nerve impulses anæsthesia takes the place of hyperæsthesia, but the pain continues (anæsthesia dolorosa) Pressure on the *anterior roots* is rarely seen except in conjunction with other and more extensive lesions In its early stages it leads to spasmodic twitchings and cramps which will later be succeeded by muscular atrophy flaccid paralysis and loss of deep reflexes Pressure on the *spinal nerve trunk* as it traverses the intervertebral foramen will provide a picture of combined motor and sensory irritation in the early stages and paralysis and anæsthesia in the later all of which are confined to the area of distribution of the nerve concerned.

B **The Spinal Cord.**—1 *Gradual Compression* —(*a*) Motor effects The earliest signs will be a weakness of voluntary movement in the toes and feet succeeded by a gradual development of spastic paraplegia with increased reflexes and the presence of an extensor plantar response and ankle clonus In the next stage the flexor group of muscles atrophy more quickly than the extensors the legs become still weaker and "paraplegia in extension" is established. Eventually all power of voluntary movement is lost and the joints of the lower limb are pulled into extreme flexion, with the thighs in contact with the abdominal wall—"paraplegia in flexion"

(*b*) Sensory changes At the level of the compression pain is experienced in the distribution of the spinal segment actually compressed These "root pains" often precede all other symptoms by many weeks and are of the greatest diagnostic importance as giving a clue to the level of the lesion Below this a loss of sensation gradually appears simultaneously with the early muscle weakness until finally a complete anæsthesia up to the segmental level of the compression is established. In the area of distribution of the segment immediately above that affected a zone of hyperæsthesia may be interposed between the areas of normal and abolished sensation

(*c*) Sphincter Control In the early stages there will be bladder irritability and some loss of control Later the behaviour of both bladder and rectal sphincters depends on the level of the lesion. If this is above the centres in the lumbar segments of the cord there will be retention of urine which passes into the condition of retention with overflow until eventually the bladder adapts itself to an involuntary emptying at definite periods over which the patient has no control—

the automatic bladder There is constipation combined with loss of control after the administration of aperients

When the lesion is low down in the cord true incontinence of both urine and fæces occurs

(*d*) Trophic changes are marked in the area below the level of the lesion and it may be impossible in spite of the most skilful and loyal nursing to prevent the occurrence of bed-sores

2 *Sudden Compression* is accompanied by the immediate onset of total flaccid paralysis with complete sensory loss below the affected level If the patient survives the shock there will be retention of urine constipation priapism and trophic changes The picture varies with the level of the lesion and will be described below

C **The Cerebrospinal Fluid.**—Should the subarachnoid space be occluded the cerebrospinal fluid becomes stagnant and certain changes occur in it These constitute Froin s syndrome the fluid being yellow in colour having a specific gravity far in excess of normal and coagulating spontaneously on standing

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paralysis appear in the areas supplied by the cauda equina and spread gradually higher and higher as the bleeding continues

Treatment consists in complete rest the injection of ergotin and adrenalin and careful attention to general nursing If the bleeding is continuing and the area and extent of the pressure increasing a laminectomy may have to be considered though it can rarely do good

Hæmatomyelia (Intramedullary Hæmorrhage) —In certain injuries the cervical spine may be violently overflexed so that the cervical part of the spinal cord is stretched without there being any injury of the vertebral column In such cases one or more hæmorrhages may occur in the region of the anterior horn cells of the lower segments of the cervical cord as a result areas of grey matter are permanently destroyed the neighbouring white matter is compressed and if the bleeding is extensive blood will rupture out of the cord into the subdural space

After the spinal concussion which follows immediately upon the accident has passed off a flaccid paralysis (lower motor neurone type) of the muscles supplied by the damaged anterior horn cells will be found According to the extent of the lesion, either all the muscles of the upper limb or certain groups only are affected In many patients the small muscles of the hand are the only ones thus paralysed In addition the pressure of the clot on the descending tracts in the cord leads to a spastic paralysis (upper motor neurone type) of the muscles of the leg Interference with sensation is variable and irregular and is frequently of that type of dissociated anæsthesia met with in syringomyelia There is usually priapism and retention of urine and as in other lesions of the cervical region Horner's syndrome is present, viz contraction of the pupil, retraction of the eyeball and narrowing of the palpebral fissure

It will be evident that the future prospects of such patients depend entirely on the extent of the hæmorrhage In some people the damage will be so severe as to constitute a virtual total transverse division of the cord and little if any recovery can be expected In the usual type of case the damaged areas in the anterior horn cells are permanently destroyed and the resultant flaccid paralysis and wasting of muscles must persist but the other lesions are due to pressure and may confidently be expected to improve or even recover completely The final defects are therefore confined to certain muscles in the arms while the legs recover There is always the possibility that death may occur in the early stages from respiratory failure while months later secondary spinal cord degenerations may set in

Treatment consists in absolute rest combined with efficient nursing Laminectomy cannot possibly serve any useful purpose in this type of lesion

Complete Transverse Lesion of the Cord

As might be expected from its small size injuries of the cord are more likely to be complete than partial and as no regeneration in the central nervous system is possible such injuries are unhappily

irremediable The cord is usually crushed by the displacement of bone in fractures or fracture-dislocations of the spine and in many cases the damage is inflicted even though the spontaneous reduction of the dislocation has occurred within a few brief moments It is with these injuries that we are chiefly concerned in civilian practice but complete lesions are produced by several other means *e g* gunshot wounds of the spine and cord and those conditions in which compression of the spinal cord occurs from spinal tumours cysts and inflammatory exudates in the later stages of which a partial compression terminates in a complete transverse lesion

General Clinical Picture—The exact distribution of the paralyses must depend on the level of the spinal injury and an analysis of the various clinical pictures follows Nevertheless it is useful to consider the general findings before passing to a detailed neurological description Two stages have to be discussed

A **The Stage of Initial Spinal Shock.**—As soon as the patient has recovered from the general physical shock of the accident there will be found below the level of the lesion total flaccid paralysis and complete anaesthesia absolute absence of all reflexes and retention of urine Of equal importance though less evident in the first few days are the trophic disturbances The feet are cold and blue there is some *oedema of the ankles and the skin rapidly becomes dry shiny thin* and almost transparent and tends to crack. Even the most devoted nursing will not always succeed in preventing bed-sores over prominent bony points and the least inattention may result in large sloughing ulcers over the sacrum The bladder muscles are paralysed, but the sphincter is in tonic spasm so that there is retention of urine and if this is not relieved, false incontinence—that is retention with overflow—results Relief of the retention adds a further element of danger *since cystitis can hardly be avoided* Should it occur it tends to be of a fulminating type which spreads rapidly to the kidneys To a lesser extent the bowel also gives rise to anxiety constipation is present and incontinence is apt to follow the use of aperients thus increasing the risk of bed-sores The technique of tidal drainage is described on p 700

B **The Stage of Spinal Reflex Activity**—If the patient has survived the formidable dangers outlined above for four weeks, a change will be observed There is no abrupt transition, but a slowly progressive alteration in the muscle reactions below the level of the lesion

The muscles remain paralysed and the limbs are without sensation but the flexor reflexes reappear in a very special way At first the *zone of skin sufficiently receptive to initiate the reflex is* confined to a small area on the foot it then spreads to include the whole of the sole and slowly week by week advances up the lower extremity until it finally embraces the whole area of skin below the level of the cord lesion Not only does the area of reception thus extend its borders but the field of response gradually spreads both in *muscle distribution* and in the force of the movement At first feeble flexion of the toes ankle and knee joints occurs but later violent contractions of all the

joints of the lower extremity are accompanied by similar movements of the abdominal muscles In time this mass reflex may follow the most trivial cutaneous stimulation

During this phase the bladder may regain its power of evacuation although this is independent of the patient s knowledge or volition. It is consequently known as the automatic bladder and after many months a patient may learn to initiate the bladder action by some quite irrational act such as stroking the skin on the inner side of the thigh further he may become aware that the involuntary act of micturition is shortly about to occur During this period the trophic disturbances become progressively less and the danger of bed-sores is diminished, until after many months the nutrition of the skin approaches normal and burns or minor septic conditions heal without much difficulty

Prognosis —In some patients (see " Upper Cervical Segments) death is instantaneous very many others do not survive the phase of spinal shock, but a certain number will live for many years Death is usually due to pulmonary infections renal failure from an ascending pyelonephritis or septicæmia from sloughing wounds or bed-sores The lower the level of the lesion the more favourable is the outlook. Providing the arms escape no patient need feel that he or she is a hopeless burden on other people or that life holds no prospects of interest and usefulness

Treatment —*A* **Prophylactic.**—It must never be forgotten that the spinal cord may be damaged not at the time of the injury but by subsequent movements No person who has sustained the type of accident likely to injure the spine should be moved until skilled aid is at hand He must then be gently turned on to his face with the trunk extended and all manipulations, such as lifting him on and off a stretcher should be done in that position.

B **The Stage of Spinal Shock.**—Treatment is directed to the prevention of complications and consists almost entirely in devoted nursing Attention is paid to preserving the integrity of the skin to treatment of the bladder (see p 700) and to overcoming constipation and gaseous distension

C **The Later Stage.**—The most dangerous period having been surmounted treatment during the succeeding months is both physical and psychological The skin bladder and bowel still need attentive care but no less important is the treatment of the utter despair of mind and spirit It is doubtful if any patient can live for any length of time unless he or she can be persuaded that life is not hopelessly futile

The Clinical Picture at Different Levels —1 THE UPPER FOUR CERVICAL SEGMENTS —Injuries to this area are immediately fatal owing to the paralysis of all muscles of respiration

2 THE LOWER CERVICAL AND 1ST DORSAL SEGMENTS —The phrenic nerve escapes and a purely diaphragmatic type of respiration remains Anæsthesia reaches to the second intercostal space The cervical sympathetic being paralysed Horner s syndrome is present namely contraction of the pupil recession of the eyeball and narrowing of the

palpebral fissure There is retention of urine constipation and priapism which is a turgid semi-erect condition of the penis The extent of the muscular paralysis varies according to the level thus (a) at the 5th cervical segment the arms are totally paralysed and lie beside the body (b) at the 6th cervical segment the deltoids the flexors and supinators are not involved the arm lying abducted at the shoulder flexed at the elbow and wrist with the forearm supinated (c) at the 7th cervical and 1st dorsal there is the same picture the intrinsic muscles of the hand being paralysed the " main d accoucheur resulting

3 THE DORSAL SEGMENTS FROM THE 2ND TO THE 12TH —The lesion is now below the level of the motor supply of the upper extremity and the arms are normal. Respiration is still partly diaphragmatic in type and is somewhat embarrassed by distension of the intestines further feebleness of the act of coughing tends to the retention of sputum so that the onset of hypostatic bronchopneumonia is an ever present danger According to the level, all or part of the inter costal and abdominal musculature is paralysed Anæsthesia is of the girdle type ending in a sharply demarcated line of hyperæsthesia passing horizontally round the body The bladder will become automatic after a time The prognosis is poor but in the lower segments is more favourable

4 THE LUMBAR SEGMENTS —The paralysis will be confined to the muscles of the lower extremity and pelvic girdle while the upper limit of anæsthesia reaches a level between the symphysis pubis and the umbilicus The greater part of the abdominal musculature having escaped respiration is free and the forcefulness of coughing is unimpaired so that there should be no anxiety with regard to pulmonary complications Priapism is not seen at this level. According to the relationship of the injury to the bladder centre there will be either retention of urine with overflow or true incontinence An automatic bladder is never established in these lesions The lower bowel is incontinent and constipation and intestinal distension are absent. The prognosis is fair

5 THE CAUDA EQUINA may escape total injury and the *picture is* apt to be somewhat complicated. Either all the muscles of the *lower* extremity and perineum are affected or the quadriceps and adductors of the thigh may escape Anæsthesia is extensive but confined to the legs There will be incontinence of both bowel and bladder but priapism does not occur It must be remembered that the nerves of the cauda equina are peripheral nerves consequently the paralysis will be of a lower motor neurone type and the prognosis as to both life and function is good *since* peripheral nerves are capable of regeneration, and laminectomy with suture may lead to complete recovery

INCOMPLETE LESIONS OF THE CORD

These injuries are not uncommon, *small* areas of the cord being lacerated or contused while spinal hæmorrhage and some injury to the spine will be associated with them. In the early stages the clinical

picture is indistinguishable from that of a complete division flaccid paralysis, loss of sensation and sphincter dysfunction being present After some days or weeks a return of function will be observed in a small part of the paralysed area. This revelation of the incompleteness of the lesion is followed by a progressive improvement and many weeks or months may elapse before the permanent damage can be estimated. Its distribution must necessarily depend on the level of the lesion as well as its extent in the cord

Treatment in the early weeks will be similar to that of a complete lesion. Later all muscles which show signs of recovery must be energetically assisted by faradism and massage The same general care and devoted nursing are needed In these partial lesions the bladder is unlikely to be permanently affected and the return of voluntary control is to be expected.

Hemisection of the Cord.—Rarely a penetrating wound by bullet or shell splinter effects an exact division of one lateral half of the cord. As a result the Brown-Séquard syndrome will be seen, viz. (a) on the affected side there is paralysis of the leg of the upper motor neurone type with active reflexes including a plantar extensor response and a loss of the sense of appreciation of the position of joints and of vibration (b) on the opposite side there is loss of all sensation of pain and temperature but no muscle paralysis. Control of the bladder is not likely to be lost.

Lesions involving Nerve Trunks may occur in any part of the spinal column. Injuries of the lower lumbar vertebræ can involve only the trunks of the cauda equina and in the other parts of the column the nerves may be compressed as they traverse the intervertebral foramina, whilst the cord itself remains undamaged. The picture is that of a lower motor neurone type of lesion and depends entirely on the nerve involved and the extent of its injury either temporary compression or complete division. Recovery may be expected after the release of pressure and, if necessary suture since regeneration is possible in peripheral nerves

Summary of Treatment.—Each section contains directions as to treatment but this subject is incomplete without some indication of the value of laminectomy So insistent is the demand that "something should be done" in these sad cases that it is important that the limitations of any operation should be clearly defined

Laminectomy can never be of use in the following conditions (1) spinal concussion (2) complete division (3) hemisection of the cord (apart from the necessary technique of wound treatment) (4) the early stage of partial lesions

It is indicated (1) in partial lesions when the localised nature of the injury has been revealed and the removal of a displaced fragment of the vertebra is possible (this is sometimes essential in the cervical region when manipulation and extension fail to overcome the signs of compression) (2) when the symptoms appear to be increasing steadily during the first few days, in order to control hæmorrhage (3) in lesions of the cauda equina to suture one or more nerve trunks (4) after the lapse of some months when symptoms of

compression suggest the presence of callus an arachnoid cyst or scar tissue (5) in penetrating wounds as part of the general technique for wound treatment

Traumatic Spinal Neurasthenia

This condition traditionally known as *Railway Spine* is seen in these days following many other accidents than those of rare occurrence on the railway systems of this country The accident is usually of great violence in which the terror and mental shock exceed the physical injury There is frequently some direct trauma to the back but it is rarely severe and actual fractures of the spine are never seen At the time the victim will profess to be unhurt will probably assist in the rescue of others and return home and to work the following day Within a week symptoms of headache backache inability to concentrate and a feeling of impending disaster appear The condition is in every respect analogous to "shell shock," with its attendant excitability nervous irritability weakness loss of memory dream racked sleep noises in the head and many other subjective symptoms Atypical areas of tingling in the skin or patchy anaesthesia may be present the bladder is irritable and there may be loss of both sexual power and desire

Examination reveals a complete absence of any positive evidence of organic disease in either the central or the peripheral nervous system The most effective treatment consists in the favourable *settlement* of all legal claims for compensation.

DISEASES OF THE SPINAL CORD

Transverse Myelitis is more usually considered in textbooks of medicine Its surgical causes are long-continued pressure on the cord by displaced bone fragments tuberculous granulation tissue or abscess callus following a fracture of the spine scar tissue or very rarely by growths It may therefore occur as a late complication of injury to the spine and cord a localised area of nerve tissue becomes softened and the microscope reveals the death of nerve fibrils and cells These changes tend to spread up the cord.

Treatment is to remove the cause as soon as symptoms are present

Acute Spinal Meningitis.—A leptomeningitis affects the membranes of the spinal cord either as a direct extension from the cranium or as a primary infection resulting from penetrating wounds or a spina bifida. In these latter cases an extension upwards into the skull is only too probable In spinal meningitis a sudden onset with one or more rigors ushers in a clinical picture of pain and muscular rigidity which is frequently spasmodic in type resembling that of tetanus When the infection spreads to the brain the prognosis is hopeless but if it remains localised to the spine recovery is possible

Treatment is directed to the relief of symptoms but in effect little can be done unless the infecting organisms are penicillin-sensitive in which case full chemotherapy may arrest the infection and lead to a complete cure Pain is sometimes relieved by repeated lumbar puncture

Chronic Spinal Meningitis (Meningitis Serosa Circumscripta) is a pachymeningitis of a chronic type It may follow the localisation of an acute attack, it may be associated with injury or syphilis and it has been described as a result of the intrathecal injection of lipiodol or percaine. There is a localised thickening of the cord and membranes, in which latter cerebrospinal fluid may collect under tension.

The *symptoms* point to a gradual localised compression of the cord, pain and muscular weakness being the first indications The picture is somewhat vague and atypical. Later a spastic paralysis of the legs develops but the bladder and bowel are not affected until very late in the disease

Treatment.—The clinical picture cannot fail to raise the suspicion of a spinal tumour and a laminectomy will be the correct procedure. If the cerebrospinal fluid has formed a localised cyst, great improvement may follow its removal.

TUMOURS OF THE SPINAL CORD AND ITS MENINGES

Tumours which cause symptoms of compression of the spinal cord may be classified as follows —

1 Extradural.
   (a) Of the bones chondroma osteoma sarcoma and secondary carcinoma.
   (b) Of the soft tissues lipoma angioma and sarcoma.
2. Intradural, but extramedullary
   (a) Benign neoplasms lipoma fibroma psammoma cavernous hæmangioma.
   (b) Malignant neoplasms sarcoma and endothelioma (meningioma)
   (c) Cysts arachnoid and hydatid.
   (d) Inflammatory swellings tuberculoma and gumma.
3 Intramedullary Malignant glioma and endothelioma

Symptoms and Signs.—If the student will refer to page 923 he will find set out the clinical picture of gradual compression of the spinal cord which is so well exemplified by tumours of the spinal cord and its meninges The symptoms are of slow onset and depend upon the site of origin of the lesion in the spinal canal and its segmental level in the cord.

In extradural tumours the pressure is likely to be exerted first upon the nerve roots of one side and then upon that half of the cord so that the picture will primarily be that of root pain, secondly unilateral cord pressure and finally general cord compression

Intradural but extramedullary swellings are the commonest of all. They give rise to a prolonged stage of root-pressure symptoms before a slowly progressive compression of the cord makes its appearance

The intramedullary tumours give no root pain but a partial paraplegia from the outset

Localisation.—The localisation of the level of a tumour is obviously of the greatest importance The clinical picture should provide a

reasonable guide but it is not always clearly defined Lipiodol (or neohydriol) injections into the spinal theca permit an exact localisation of the obstruction by X rays

Diagnosis is by no means easy for syphilis syringomyelia disseminated sclerosis and chronic spinal myelitis may at times prove most misleading

Treatment.—Every patient suspected of a spinal cord tumour should be offered operation. The extradural and extramedullary tumours are usually on the posterior or postero-lateral aspect of the cord, and can frequently be removed with success The intramedullary types are probably not amenable to removal but even in these the decompression brought about by laminectomy will give considerable relief for a time

DISEASES OF THE SPINAL COLUMN

Acute Osteomyelitis of the Spine occurs in children and adolescents but is rare Its pathology is identical with that in the long bones the causative organism being the *S aureus* It involves the body or laminæ of either a cervical or lumbar vertebra It is characterised by intense pain in the back fever and toxæmia Owing to the danger of spread to the meninges the prognosis is very bad Rapid destruction of bone occurs and abscesses form.

Treatment consists in immediate penicillin therapy early incision to ensure adequate drainage and immobilisation of the spine with extension If the patient survives one or more sequestra will need to be removed.

Typhoid Osteitis of the Spine is also a rare condition occurring during convalescence from typhoid fever The lower dorsal and lumbar vertebræ are commonly the site of the lesion. The onset is sudden, the patient complaining of pain in the back, and on examination the spine will be found to be rigid and tender and there will be a high pyrexia The history of typhoid fever a positive Widal reaction and the radiographic appearance of necrosis accompanied by the formation of new bone serve to distinguish it from osteomyelitis and tuberculous disease of the spine

Treatment.—Pus does not always form and conservative treatment with immobilisation of the spine may lead to recovery If pus does form it must be given adequate drainage

Tuberculous Disease of the Spine is described in full in Chap XLVIII

Syphilis of the Spine is fortunately one of the rarer manifestations of the acquired form of this disease in its tertiary stage Gummatous lesions and periostitis are met with chiefly in the cervical region and simulate Pott's disease very closely The history the positive Wassermann reaction and the sclerosis of bone in an X ray should lead to a correct diagnosis

Treatment is by the usual specific methods

Arthritis of the Spine.—Arthritis deformans affects the spinal column in a manner similar to other joints RHEUMATOID ARTHRITIS occurs in rheumatic subjects and its clinical picture is similar in many respects

to the manifestations of rheumatism elsewhere It attacks the cervical segments most commonly and affects the muscles and ligaments, so that pain, limitation of movement and even a deformity comparable to torticollis result The treatment is directed toward the rheumatism

OSTEO-ARTHRITIS differs in no way from the disease in the larger joints It is very common in both sexes after the age of forty years especially among people whose work has entailed a great deal of stooping and exposure It affects chiefly the lower dorsal and lumbar regions The cartilages are thinned and fibrillated while osteophytic outgrowths form at the margins of the upper and lower surfaces of the vertebræ The symptoms are pain and stiffness in the back, made worse by damp cold and unwonted exercise In early cases manipulation of the spine under general anæsthesia may effect considerable improvement while later treatment is directed to the underlying cause Locally pain can be relieved—at least temporarily—by heat and short-wave diathermy

Spondylitis Deformans is a disease of uncertain etiology which leads eventually to almost complete rigidity of the spine Although in many respects similar to simple osteo-arthritis in some details it displays characteristic qualities Two pathological types are described (a) the osteo-arthritic type in which there is marked hypertrophy and condensation of the bones, with extensive formation of osteophytes from the vertebral bodies while the changes also affect equally the intervertebral articulations (b) the ligamentous type in which the bones are rarefied and osteophytes are not formed to any extent. The intervertebral discs atrophy and widespread ossification occurs in all the ligaments, viz. anterior spinal interspinous costo-transverse etc

Clinically also two types are differentiated (1) The Marie-Strümpell type (spondylitis rhizomélique) affects not only the spine but also the root joints i e. shoulder and hip There is no involvement of the central nervous system. It starts in the lumbar region and spreads upwards affecting both sexes equally and being uncommon before 35 years of age (2) The von Bechterew type (spondylitis heredo-traumatique) occurs in males only and at a much earlier age (after 15 years) It commences in the cervical region and spreads rapidly throughout the spine A certain number of patients develop a local meningitis in the cervico-dorsal segment of the cord

The *symptoms* are pain stiffness and deformity until finally the spine becomes completely rigid (the poker back " spine) The prognosis is extremely poor and until ankylosis has occurred, pain is severe and persistent

Treatment is directed to the relief of pain and the prevention of deformity

Osteo-arthritis of the Sacro-iliac Joint is by no means uncommon, especially in women The only symptom is a dull persistent aching pain either in the region of the joint behind or referred to the front in either iliac fossa Patients frequently come for advice complaining of low abdominal pain. and when this occurs in the right side many of them are diagnosed as examples of chronic appendicitis The

early cases are relieved by a manipulation under anaesthesia and if this fails the injection of proctocaine sometimes achieves immediate success

Sacralisation of the Lumbar Spine—The 5th lumbar vertebra may either wholly or in part take part in the formation of the solid sacrum Usually the changes affect the transverse processes which are greatly enlarged and may form a joint or fuse completely with the ilium or sacrum these changes may be unilateral or bilateral A large number of such abnormalities are devoid of all symptoms but in some patients the deformity leads to pressure on the 4th and 5th lumbar nerves scoliosis or localised sacro-iliac pain

Treatment is symptomatic except in very severe cases in which resection of the overgrown transverse process may be required.

Epiphysitis of the Spine (Scheuermann's disease)—The lips of the upper and lower surfaces of the vertebræ are developed from secondary centres. These occasionally undergo changes similar to those in the femoral head and tibial tubercle. Symptoms are pain, malaise and the gradual development of a kyphosis

Treatment is by immobilisation for three months

Coccydynia.—Pain in the bottom of the spine is a frequent condition in women, and in the absence of a fracture or dislocation is invariably a symptom of neurasthenia. There is usually a history of a minor injury to this region in the shape of a fall or blow and the pain is described as being excruciating It is made worse by sitting walking and defæcation. On examination nothing abnormal will be found, but manipulation between a finger in the rectum and the thumb externally produces agonising pain."

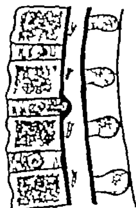


FIG 448

Diagram illustrating prolapse of the nucleus pulposus.

Treatment—If a fracture or dislocation has resulted in a forward displacement of the lower segments of the coccyx, which has not been properly reduced the coccyx must be removed. But in all other cases operation is definitely harmful, as the pain persists. A dramatic and lasting recovery is usually obtained by the injection of proctocaine in front of and behind the coccyx. General treatment is directed towards the underlying neurosis

Prolapse of the Nucleus Pulposus of an intervertebral disc in the lumbar region is a well recognised cause of compression The anterior surface of the cord or more probably one or more nerves of the cauda equina suffers most from the compression (Fig 448) This lesion has become more frequent in recent years and in a great many patients causes sciatica although the affected disc is not always in the lumbar region. In many patients a narrowing of the space between the vertebral bodies can be seen in X ray films

Treatment—In the past treatment consisted in laminectomy and removal of the prolapsed tissue The results have proved to be far

to the manifestations of rheumatism elsewhere It attacks the cervical segments most commonly and affects the muscles and ligaments, so that pain, limitation of movement and even a deformity comparable to torticollis result The treatment is directed toward the rheumatism

OSTEO-ARTHRITIS differs in no way from the disease in the larger joints It is very common in both sexes after the age of forty years especially among people whose work has entailed a great deal of stooping and exposure It affects chiefly the lower dorsal and lumbar regions The cartilages are thinned and fibrillated while osteophytic outgrowths form at the margins of the upper and lower surfaces of the vertebræ The symptoms are pain and stiffness in the back, made worse by damp cold and unwonted exercise. In early cases manipulation of the spine under general anæsthesia may effect considerable improvement while later treatment is directed to the underlying cause Locally pain can be relieved—at least temporarily—by heat and short-wave diathermy

Spondylitis Deformans is a disease of uncertain etiology which leads eventually to almost complete rigidity of the spine Although in many respects similar to simple osteo-arthritis in some details it displays characteristic qualities Two pathological types are described (*a*) the osteo-arthritic type in which there is marked hypertrophy and condensation of the bones with extensive formation of osteophytes from the vertebral bodies while the changes also affect equally the intervertebral articulations (*b*) the ligamentous type in which the bones are rarefied and osteophytes are not formed to any extent The intervertebral discs atrophy and widespread ossification occurs in all the ligaments viz. anterior spinal, interspinous, costo-transverse etc

Clinically also two types are differentiated (1) The Marie-Strümpell type (spondylitis rhizomélique) affects not only the spine but also the root joints, *i.e* shoulder and hip There is no involvement of the central nervous system It starts in the lumbar region and spreads upwards affecting both sexes equally and being uncommon before 35 years of age (2) The von Bechterew type (spondylitis heredo-traumatique) occurs in males only and at a much earlier age (after 15 years) It commences in the cervical region and spreads rapidly throughout the spine A certain number of patients develop a local meningitis in the cervico-dorsal segment of the cord

The *symptoms* are pain, stiffness and deformity until finally the spine becomes completely rigid (the poker back" spine) The prognosis is extremely poor and, until ankylosis has occurred pain is severe and persistent

Treatment is directed to the relief of pain and the prevention of deformity

Osteo-arthritis of the Sacro-iliac Joint is by no means uncommon, especially in women The only symptom is a dull persistent aching pain either in the region of the joint behind or referred to the front in either iliac fossa Patients frequently come for advice complaining of low abdominal pain and when this occurs on the right side many of them are diagnosed as examples of chronic appendicitis The

early cases are relieved by a manipulation under anæsthesia and if this fails the injection of proctocaine sometimes achieves immediate success

Sacralisation of the Lumbar Spine.—The 5th lumbar vertebra may either wholly or in part take part in the formation of the solid sacrum Usually the changes affect the transverse processes which are greatly enlarged and may form a joint or fuse completely with the ilium or sacrum these changes may be unilateral or bilateral A large number of such abnormalities are devoid of all symptoms but in some patients the deformity leads to pressure on the 4th and 5th lumbar nerves scoliosis or localised sacro-iliac pain.

Treatment is symptomatic except in very severe cases in which resection of the overgrown transverse process may be required.

Epiphysitis of the Spine (Scheuermann's disease) —The lips of the upper and lower surfaces of the vertebræ are developed from secondary centres These occasionally undergo changes similar to those in the femoral head and tibial tubercle Symptoms are pain, malaise and the gradual development of a kyphosis

Treatment is by immobilisation for three months.

Coccydynia.—Pain in the bottom of the spine is a frequent condition in women, and in the absence of a fracture or dislocation is invariably a symptom of neurasthenia There is usually a history of a minor injury to this region in the shape of a fall or blow and the pain is described as being excruciating It is made worse by sitting walking and defæcation. On examination nothing abnormal will be found, but manipulation between a finger in the rectum and the thumb externally produces agonising pain "

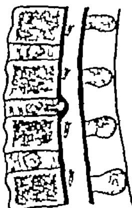


FIG. 448

Diagram illustrating prolapse of the nucleus pulposus.

Treatment —If a fracture or dislocation has resulted in a *forward* displacement of the lower segments of the coccyx which has not been properly reduced the coccyx must be removed. But in all other cases operation is definitely harmful as the pain persists. A dramatic and lasting recovery is usually obtained by the injection of proctocaine in front of and behind the coccyx. General treatment is directed towards the underlying neurosis

Prolapse of the Nucleus Pulposus of an intervertebral disc in the lumbar region is a well-recognised cause of compression The anterior surface of the cord, or more probably one or more nerves of the cauda equina suffers most from the compression (Fig 448) This lesion has become more frequent in recent years and in a great many patients causes sciatica," although the affected disc is not always in the lumbar region. In many patients a narrowing of the space between the vertebral bodies can be seen in X ray films.

Treatment —In the past, treatment consisted in laminectomy and removal of the prolapsed tissue The results have proved to be far

from satisfactory and to-day patients are treated in recumbency for four weeks with active extension of the spine

Growths of the Spine.—Benign tumours of the spine are rare they comprise chondroma and osteoma The malignant growths are primary and secondary Primary sarcoma is unusual. The commonest of all spinal tumours are the secondary carcinomata from the breast in the female the prostate in the male and the thyroid, stomach and kidney in both sexes

The Clinical Picture is very typical. Pain is of sudden onset becomes increasingly severe and is uninfluenced by rest At first localised to the vertebra concerned it later spreads to the area supplied by the nerves emerging from the affected segments of the spine Eventually the spinal canal is invaded and the cord compressed so that paraplegia follows A kyphosis is present in a certain percentage of patients and is due to collapse of the vertebral bodies The condition is rapidly progressive and constitutes one of the more sad endings to malignant disease.

Treatment can be directed solely to the relief of pain and in this connection X rays and radium play an important part The insertion of radon seeds is entirely justified if it results in the cessation of pain.

Deformities of the Spinal Column

All types of deformity of the spine are dealt with in full in Chap XLIX

R M Handfield-Jones.

CHAPTER XLIII

INJURIES AND DISEASES OF THE NERVES

SURGICAL ANATOMY.—An axis cylinder or nerve fibril is developed from a central nerve cell and its ability to transmit stimuli depends on the integrity of this connection. A number of axis cylinders are bound together by connective tissue to form a nerve fibre bundles of which collected together constitute a nerve The connective tissue carries blood vessels and lymphatics. In medullated nerves each axis cylinder has a medullary or myelin covering enclosed in the neurilemma or sheath of Schwann non medullated nerves have neurilemma but no medullary sheath

The twelve cranial nerves emerge from the base of the brain and tend to be either purely motor or purely sensory in function. The spinal nerves arise in each spinal segment from the anterior (motor) and posterior (sensory) roots, which unite to form the main nerve trunk this passing out between the adjacent vertebræ Spinal nerves may remain single or unite with their neighbours to form plexuses, *e.g.*, the brachial lumbar and sacral, but before doing so each trunk receives a branch from the sympathetic nervous system The peripheral nerves are the result of this fusion, and consist of motor sensory and sympathetic fibres except in the case of a few purely sensory nerves such as the radial, internal cutaneous and long saphenous The motor fibres which supply the voluntary muscles arise from the cells of the anterior horn. The involuntary muscles are supplied by the sympathetic system except those which receive their innervation from certain cranial nerves such as the vagus

Three different types of stimuli are conveyed by sensory fibres, viz protopathic epicritic and deep sensations.

1 Protopathic sensation is the appreciation of pain and marked differences in temperature It is not a highly specialised sense and the fibres concerned regenerate more quickly and completely than the others It is tested for by sharp pin prick and with test tubes of hot and cold water

2. Epicritic sensation is more highly specialised and consists in the appreciation and accurate localisation of the lightest touch and of small differences of temperature It is of the greatest importance in the co-ordination of delicate muscular movements, and recovery after injury is slow and often imperfect. Wisps of cotton wool and test tubes of water of slightly differing temperatures are used for testing it.

3 Deep sensibility and the appreciation of the position of joints and the movements of muscles are transmitted by the nerves which supply the muscles and tendons, and remain unchanged when cutaneous nerves are injured, provided that the muscles and tendons have escaped damage Deep sensation is tested for by deep pressure while the appreciation of position, shape and texture of objects (stereognosis) is analysed by asking a blindfolded patient to describe the position of a limb and the character of an object held in the hand. There is a certain amount of overlap in the areas supplied by sensory nerves, this being more marked in protopathic than

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aspect of the internal condyle adds still further to the relief of tension, so that apposition becomes possible in most cases. The bulb neuromata are then removed by a clean cut with a scalpel and the suturing done in the same way as in a primary operation. Every effort must be made to obtain end to-end union without tension, for if this fails the results of alternative operations are most disappointing The implantation of each cut end into a neighbouring healthy nerve in the hope that the fibrils will grow down it and so gain the distal end, the turning down of flaps of the nerve and the shortening of the bones of a limb have all been tried with poor results.

The treatment after secondary suture is similar to that following primary suture but the time required is very much longer When a joint has been flexed to obtain apposition, the limb must be splinted in that position for three weeks and then slowly and gradually straightened. Relaxation of the paralysed muscles by splinting follows and massage and electrical treatment must be persisted in. The process is a slow one and the prognosis depends to some extent on the interval between injury and suture while in some patients, in spite of apparently accurate suture no regeneration occurs. When all hope of recovery has been given up, function must be restored as far as possible by carefully planned tendon transplantations

Long delay in suturing a nerve should be avoided. As a general rule eighteen months after the original injury are considered the limit for hope of recovery of function in the muscles supplied although the sensation may be improved.

The use of autogenous grafts in the closure of large gaps in nerves, where direct end to-end suture is unobtainable is now being carried out with success.

Partial Division of a Nerve may be either due to penetrating wounds or physiological without any visible tear The fibres which are severed retract and form a false neuroma, which may be centrally or laterally situated, according to the position of the injury There will be paralysis of the muscles concerned with a modified reaction of degeneration, while those supplied by the uninjured fibres remain normal Sensory changes will also be more localised. In some cases an irritative lesion of the nerves develops which gives rise to an intense burning pain in the skin supplied This is known as "causalgia" and may be very severe occurring in paroxysms which are brought on by such mild stimuli as warmth or light touch and in severe cases even by mental stimuli such as lights and noise

In partial lesions after the exact extent of the damage has been determined, the nerve should be exposed if there has been no improvement after three months The scar tissue and the neuroma are carefully excised, the cut ends trimmed and sutured, the intact portion of the nerve being disturbed as little as possible In some cases of causalgia this will suffice but in others the symptoms persist and are so severe that it may be necessary to resect the nerve or inject alcohol into it.

Pressure on Nerves.—A nerve may be compressed by scar tissue or stretched and pressed on by callus following a fracture The

symptoms of tingling loss of sensation muscular weakness and wasting will not be noticed for some weeks or months after the original injury If no improvement is seen after three months observation or if the *symptoms are obviously* increasing the nerve must be exposed and freed from the contracting scar tissue or displaced so that it can no longer be compressed *It should* be buried in muscle or wrapped in amnioplastin. The nerves of the arm are sometimes injured by the pressure of tables chairs or splints for example crutch palsy is due to pressure of a crutch in the axilla on the musculospiral nerve Saturday-night palsy is due to the pressure of the back of a chair upon the brachial nerve trunks in a patient who falls into a drunken sleep in this position "operation table palsy is due to the arm being allowed to hang over the edge of the table during an operation Tourniquets left on too long or applied over unsuitable points may cause temporary paralysis The lesions are usually slight and transient but careful splinting, massage and electrical treatment will be necessary in the more severe cases Very rarely reaction of degeneration sets in and an exposure of the nerve will be needed to remove the cause of the pressure

Neuritis and Neuralgia.—These conditions are of medical rather than surgical interest but it is important in their treatment to place the affected part at rest in a position of relaxation by suitable splints or plaster Care must be taken to prevent deformities as a result of any paralysis which may develop and the tone of the muscles must be maintained by massage and electrical treatment.

Neuralgia is a symptom of an irritative lesion of the nerve and this must always be searched for When the cause cannot be deter mined the nerve itself will have to be treated to relieve the *paroxysms of pain.* Sensory nerves are treated by injection of 80 per cent alcohol or by division or resection of their main trunks (trigeminal *neuralgia* p 916) Motor nerves cannot be treated so drastically and resort must be had to stretching

Growths of nerve arise either from the nerve tissue itself or from the *fibrous* tissue of the sheath, and are called neuromata The true *neuroma* is a *rare tumour* seen only in the posterior abdominal sympathetic system and may contain ganglion cells The false neuroma is fibromatous in structure and may be single or multiple In the single form a nodule can be felt in the line of the nerve, and can be moved transversely across but not up and down the long axis of the nerve. The tumour may be a fibrosarcoma, in which case its rapid growth, fixation to surrounding structures and interference with the function of the nerve will determine the diagnosis. *Multiple neurofibromatosis* of von Recklinghausen occurs in families and is associated with pigmentation of the skin and nodules scattered along both the subcutaneous and deep *nerves* A diffuse enlargement due to fibrous changes in the branches of a nerve or of contiguous nerves leads to a condition known as *plexiform neuroma* Schwannomata (or neurinomata) are benign encapsulated tumours of the Schwann cells and can be enucleated without damage to the nerve

AFFECTIONS OF INDIVIDUAL NERVES

SPINAL NERVES

The Cervical Plexus is injured in association with fractures and dislocations of the cervical vertebræ. The nerve lesion is rare and is greatly overshadowed by the vertebral injury and that of the spinal cord

The Phrenic Nerve is injured by penetrating wounds or during operations Irritation causes hiccough When one phrenic nerve is paralysed the corresponding half of the diaphragm rises instead of moving downwards during inspiration When both are paralysed the abdomen is sucked in during inspiration instead of being protruded.

The operation of crushing or avulsion of the nerve is sometimes practised in cases of early unilateral pulmonary tuberculosis to reduce the lung movements

THE NERVES OF THE UPPER EXTREMITY

The Brachial Plexus

Anatomy—The brachial plexus is formed from the anterior primary divisions of the 5th 6th 7th, 8th cervical and the 1st dorsal nerves. The root supply of the muscles of the upper extremity can be given as follows —

5th Cervical	Rhomboids, supraspinatus and infraspinatus, deltoid, biceps, brachialis anticus and the supinators of the forearm.
6th Cervical	Clavicular head of pectoralis major serratus magnus, the pronators, and the radial extensors of the wrist.
7th Cervical	Sternal head of pectoralis major triceps, extensor carpi ulnaris and the extensors of the fingers.
8th Cervical	The flexors of the wrist and fingers.
1st Dorsal	The intrinsic muscles of the hand.

Injuries are caused by stretching or tearing when the arm is violently pulled away from the body by direct contusion by fracture or dislocation of the spine clavicle or shoulder by penetrating wounds and by the pressure of scar tissue callus, tumours or a cervical rib The injury may be complete or partial, and affect either the spinal nerves the cords, trunks or branches of the plexus It is important that diagnosis should include exact localisation of the injury within the plexus

WHOLE PLEXUS TYPE.—These injuries are rare and are produced by violent wrenching of the arm away from the body *e.g* when a workman's hand is trapped in rotating machinery and he is whirled round and round, or when a man seeking to board a fast moving vehicle grips the handrail but fails to secure foothold Flaccid paralysis of all the muscles of the arm, forearm and hand is present and usually the deltoid and pectoralis are affected but only in very high lesions will the rhomboids and spinati or serratus magnus be involved. Anæsthesia is present over the whole arm except over the deltoid and inner aspect of the upper two-thirds of the arm If the 1st dorsal nerve is injured high up, the sympathetic fibres will be

torn and contraction of the pupil enophthalmos and absence of sweating in the face and arm on the side of the lesion are present Expectant treatment should be adopted the arm being placed in a light metal splint the humerus abducted to 90 and externally rotated the elbow flexed to a right angle the forearm supinated and the wrist and hand slightly dorsiflexed Massage and electrical treatment are given to all the paralysed muscles for at least three months If no improvement is seen and if the reaction of degeneration is present operative exposure must be considered.

Upper Arm Type.—The Erb-Duchenne palsy is by far the most common injury and is due to a lesion of either the 5th or the 6th and 7th cervical anterior primary divisions It frequently arises from a birth injury the head being stretched away from the shoulder during a difficult delivery In later life falls on the side of the head or the point of the shoulder which violently separate them may cause this type of lesion.

Symptoms—The arm hangs uselessly by the side and is internally rotated the elbow is extended and the palm faces backwards (waiter s arm) Flaccid paralysis is present in the deltoid, supraspinatus, infraspinatus, biceps coraco-brachialis brachialis anticus and supinators and occasionally in the extensors of the wrist There is a small area of anæsthesia over the outer aspect of the arm.

Diagnosis—The history of a prolonged and difficult labour or of a definite injury makes diagnosis easy and, further there is tenderness on deep pressure in the supraclavicular triangle. In adults with an incomplete lesion, pressure causes tingling in the distribution of the 5th nerve. A fractured clavicle at birth may cause difficulty because the infant does not move the arm and the root of the neck is tender but an X-ray and the absence of paralysis will reveal the real lesion. Acute arthritis of the shoulder and syphilitic epiphysitis of the head of the humerus give rise to a pseudoparalysis but there is swelling around the shoulder and signs of true palsy are absent. Long-standing cases of Erb s palsy must be distinguished from anterior poliomyelitis and from muscular dystrophy of the scapulo-humeral type Infantile paralysis will be recognised by its acute onset in a previously healthy child while in muscular dystrophy both shoulders are affected and the scapulæ will show winging

Treatment—Erb s palsy is usually incomplete and recovery is good in every case if diagnosed at once and treated efficiently The arm is held in a Fairbank's splint in the position already described *i.e.*, shoulder abducted and externally rotated elbow flexed to a right angle forearm supinated and wrist dorsiflexed. Massage and galvanic stimulation are necessary for a long time Failure of recovery and development of the reaction of degeneration point to a complete lesion, the results following *operation* for which are far from satisfactory

Lower Arm Type —Klumpke s palsy is due to an injury to the 1st dorsal nerve and frequently to the 8th cervical. It may be caused by birth injuries or by the wrench *sustained* when a falling person attempts to save himself by grasping some support.

Symptoms.—Flaccid paralysis of all the intrinsic muscles of the hand results from injuries to the 1st dorsal nerve and when the 8th cervical is also injured there will be paresis of the flexors of the wrist and fingers The patient will be unable to adduct or abduct the fingers or to oppose the thumb Later the wasting of the thenar hypothenar and interossei muscles leads to a claw hand, the fingers *being hyperextended at the metacarpophalangeal and flexed at the* phalangeal joints. The sensation of the hand is not impaired, but anaesthesia is present over the inner aspect of the arm and forearm. Injury to the 1st dorsal nerve close to the cord involves the sympathetic fibres causing enophthalmos narrowing of the palpebral fissure and contraction of the pupil, which dilates either very slowly or not at all. The eye symptoms denote an injury so close to the cord that operation is hardly likely to do good but fortunately these brachial plexus lesions are usually incomplete as is shown by the dilatation of the pupil when cocaine is instilled.

Diagnosis.—The history of an injury is as a rule present, but the condition has to be distinguished from anterior poliomyelitis and from the cervical rib syndrome

Treatment consists in splinting to relax and support paralysed muscles, combined with prolonged massage and electrical stimulation. If the reaction of degeneration sets in, operative exposure must be undertaken. The further the nerve lesion is from the cord the more hopeful the prognosis.

Injuries to the Cords.—The inner outer and posterior cords may be injured by fractures of the clavicle scapula or humerus and by subsequent attempts at reduction. The injury most commonly takes the form of compression and is rarely complete

THE INNER CORD is most frequently involved, and there results a paralysis of all the intrinsic muscles of the hand and those of the forearm supplied by the ulnar nerve a claw-hand being produced Anaesthesia is present over the inner aspect of the arm and forearm and the ulnar area of the hand.

THE OUTER CORD injury is rare and results in paralysis of the biceps coraco-brachialis brachialis anticus and those flexors of the wrist and fingers supplied by the median nerve The intrinsic muscles of the hand derive their innervation from the inner cord and are therefore unaffected. Anaesthesia is present over the outer surface of the fore-arm and the median area of the hand.

THE POSTERIOR CORD is also seldom injured. It results in paralysis of the deltoid supraspinatus infraspinatus triceps. teres major and minor and the muscles supplied by the musculospiral nerve Anaesthesia is limited to a small area on the outer aspect of the arm and forearm.

Treatment consists in splinting to relax the muscles and prevent deformity and in massage and galvanism, but the onset of the reaction of degeneration will determine the necessity for exploration and repair of the injured cord.

The Long Thoracic Nerve of Bell may be injured in the neck by penetrating wounds, blows and pressure from weights carried on the

shoulder It has been damaged in operations on the neck and axilla during the radical treatment of carcinoma of the breast Uncomplicated injuries of this nerve cause paralysis of the serratus magnus When it is compressed by heavy weights carried on the shoulder the branches of the 3rd and 4th cervical nerves to the lower part of trapezius and the nerve to the rhomboids are usually involved at the same time

Symptoms—If the serratus magnus alone is paralysed little deformity is visible when the arm hangs at the side except that the inferior angle of the scapula is more prominent than that of the opposite side The patient cannot raise the arm forwards in front of the body above the level of the shoulder nor can he push forward against resistance at the level of the shoulder attempts to carry out these movements being accompanied by marked *winging of the scapula* Similar movements can be performed below the shoulder level unless the lower part of the trapezius is also injured. In these combined nerve lesions, winging and tilting of the scapula are marked even when the arm is held at the side and this deformity is increased immediately any pushing movement is attempted

Treatment—These injuries are usually incomplete and support of the paralysed muscles with massage and galvanic stimulation suffice to bring about a complete recovery With the onset of the reaction of degeneration the nerve should be exposed and sutured, and if this fails the deformity of the scapula may be corrected by transplanting the insertion of the lower part of the pectoralis major into the inferior angle of the scapula.

The Nerve to the Rhomboids is rarely injured alone, but if this should happen the scapula is on a lower level than its normal fellow its inferior angle is carried away from the midline and its spine lies more obliquely

The Suprascapular Nerve.—Injuries to this nerve cause wasting and paralysis of the supraspinatus and infraspinatus with weakness in abduction and external rotation of the arm. The lesion is incomplete and the usual treatment will suffice

The Circumflex Nerve is injured by direct wounds or blows fractures of the surgical neck of the humerus dislocations of the shoulder and compression from crutches The deltoid and teres minor are paralysed and abduction of the shoulder is lost Marked wasting of the deltoid is present There is a small area of anæsthesia over the posterior border of the deltoid Lesions of the 5th cervical nerve give rise to a similar disability but are characterised by paralysis of the spinati and a larger area of anæsthesia

If an injury to the circumflex nerve is suspected the arm should be held in abduction to a right angle on an abduction splint and massage and electrical treatment given to the deltoid Even when the paralysis of this muscle is complete other muscles will in time overcome the disability and operation is never required

The Musculospiral Nerve may be injured by penetrating wounds but the damage is usually subcutaneous The dislocated head of the humerus old fashioned crutches and the sharp edge of a chair over which the drunken man hangs his arm are causes of compression lesions in the

axilla in the arm itself the nerve winds round the humerus and is liable to injury in fractures of the middle and lower thirds of the shaft and it may later be involved in the callus A tourniquet applied too tightly or left on too long will cause damage.



Fig. 449

The dropped wrist position resulting from musculospiral nerve palsy

The resultant paralysis involves the extensors of the wrist thumb and fingers causing wrist drop (Fig 449) and pronation of the forearm Supination of the flexed arm can still be carried out by the biceps but the patient cannot voluntarily extend the wrist or fingers If the lesion is high up active extension of the elbow will be lost owing to paralysis of the triceps and anconeus As the wrist is flexed, the grip is weak, since the extensors are unable to extend and stabilise the wrist to assist the action of the flexors If the wrist and proximal phalanges are held in extension the interossei and lumbricals are able to straighten the middle and distal phalanges When the nerve is injured above the origin of the external cutaneous branch, there will be anesthesia over a small area on the back of the radial side of the hand and thumb but injuries below this level cause no sensory loss

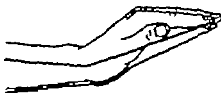


Fig. 450

The hand in a Robert Jones long cock-up splint.

The majority of musculospiral nerve injuries are incomplete but even in complete lesions the prognosis is good The wrist and fingers are held in hyperextension on a Robert Jones a long cock-up splint (Fig 450) and massage and galvanic stimulation given until signs of active extension of the wrist return. If the reaction of degeneration sets in or if there are no signs of improvement in three months the nerve must be exposed and freed. The results of operation on the musculospiral are superior to those on all others except its counter part in the lower limb—the external popliteal—probably because it is largely a motor nerve When the nerve lesion is discovered in association with fractures of the humerus operation should always be advised not only to repair the nerve but to restore the fracture If all treatment has proved unsuccessful various tendon transplantations can be done to restore the extension of the wrist



Fig. 451

Wasting of the thenar eminence in median nerve palsy

The posterior interosseous nerve is occasionally injured by posterior dislocations or fractures of the head of the radius or by operations in this region. Proper treatment of the dislocation or fracture with support massage and electrotherapy to the paralysed extensors will usually achieve a good recovery Operation should be performed if no recovery is seen after two months



Fig 451. Diagram illustrating the movement of the thumb when the median nerve is undamaged.

The Median Nerve is commonly injured in any part of its course more especially by incised wounds in front of the wrist and by becoming involved in fractures around the elbow Such severe disability of the hand results that early recognition and prompt treatment are of paramount importance

Injury in Front of the Wrist —The abductor opponens and outer half of the flexor brevis pollicis are paralysed and there is marked wasting of the thenar eminence (Fig 451) and flattening of the hand as the thumb falls back into the same plane as the fingers. Abduction and opposition of the thumb are lost (Fig 452) Attempts to produce opposition of the tip of the thumb to the tip of the little finger result in flexion and adduction of the thumb the patient being unable to bring the thumb forward from the plane of the fingers and swing it across the palm. Abduction to a small extent can be simulated by the *extensors* but again the thumb remains in the plane of the fingers

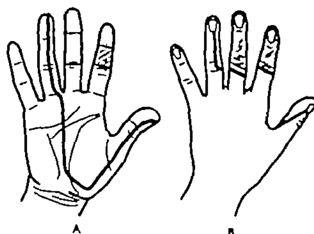


Fig. 453

A, diagram showing the extent of anaesthesia on the palmar aspect as the result of division of the median nerve at the wrist; B, the changes on the dorsal aspect of the hand. The heavily shaded area represents the loss of protopathic sensation while the whole area enclosed in the heavy black line shows the extent of the epicritic loss.

Anaesthesia is present throughout the anatomical distribution of the nerve Epicritic sensation is lost over the outer half of the palm over the palmar aspect of the index middle and radial half of the ring fingers and over the dorsal aspect of the distal two-thirds of these fingers Protopathic loss is much less extensive and is confined to the distal half of the index and middle fingers (Fig 453 A and B)

Injury Near to Elbow —The following muscles are paralysed in addition to the above *pronator radii teres* flexor carpi radialis, flexor longus pollicis pronator quadratus all the flexor sublimis digitorum and the outer *half of the flexor profundus*

digitorum The patient will also lose the power of pronation radial deviation of the wrist and flexion of the index and middle fingers. Anæsthesia remains as before with the addition of some loss of deep sensibility over a small part of the area

FIG. 434

Wasting of muscles between thumb and index finger in ulnar nerve palsy

Trophic changes are well marked in both lesions, and the skin and nails are seriously affected. Causalgia is particularly likely to occur in partial injuries of this nerve

Treatment —Every wound in front of the wrist should be regarded as containing a severed median nerve until exploration has proved the contrary Immediate primary suture is the best possible treatment If the injury is unrecognised secondary suture should be undertaken as soon as latent sepsis has disappeared The *prognosis is not altogether satisfactory* but so serious is the disability of a complete median injury that operation must be performed in every case



FIG. 455

The *main-en-griff* position of the hand in lesions of the ulnar nerve

The Ulnar Nerve is liable to injury in fractures of the internal condyle of the humerus and of the olecranon, and in dislocations of the elbow and shoulder It may be involved at the time of the actual injury during subsequent attempts at reduction or compressed later by callus or scar tissue It may also be severed in cuts in the front of the wrist or forearm, or on inner aspect of upper arm

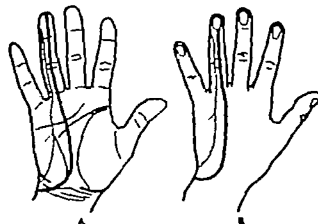


FIG. 456

Diagram showing loss of sensation after division of the ulnar nerve A, palmar and B, dorsal aspect of the hand. Areas of shading as Fig. 453.

INJURY AT THE WRIST —The muscles of the hypothenar eminence the adductor transversus and adductor obliquus pollicis the deep or long head of the flexor brevis pollicis the two inner lumbricals and *all* the *interossei* are paralysed. Marked wasting of the hypothenar muscles and in all the

interosseous spaces particularly between the thumb and index finger ensues (Fig 454) The following movements are lost When the fingers are fully extended the patient cannot abduct or adduct them Adduction of the thumb is impossible i.e. the thumb cannot be moved from the abducted position into contact with the radial border of the palm. The metacarpophalangeal joints cannot be flexed or the inter phalangeal joints extended The hand is therefore held in the "claw hand" or *main-en-griffe* position (Fig 455) with the *metacarpophalangeal* joints hyperextended and the phalangeal *joints flexed* The "clawing" does not affect the index and middle fingers so much as the others as their lumbrical muscles are not affected.

Epicritic sensation is lost over the ulnar portion of the hand the palmar surface of the little and the ulnar half of the ring fingers and the dorsal surface of these two fingers from their tips half way up them. Protopathic sensation is lost over a varying and usually very small area. Trophic changes in the anaesthetic area are well marked When the nerve is divided above the level of origin of the dorsal cutaneous branch there is an extension of the area of epicritic loss over the dorsal area of the hand and of the ring and little fingers together with a less pronounced increase in protopathic loss (Fig 456 A and B)

INJURY AT OR ABOVE THE ELBOW —The paralysis now includes the flexor carpi ulnaris and the inner half of the flexor profundus digitorum so that further weakness in the power of flexion, of ulnar abduction of the wrist and of the grip follows. The clawing of the hand is still more marked. Loss of deep sensibility will also be present in the ulnar part of the hand.

Treatment is exactly similar to that for median nerve injuries and the same principles apply

There is another injury of the ulnar nerve at the elbow which needs description viz recurrent dislocation from the groove behind the internal condyle when the elbow is flexed. If it is not treated a traumatic neuritis will be set up and signs of incomplete physiological division follow Operative treatment is essential, the nerve being either sutured back in the groove or preferably displaced in front of the condyle and buried in the muscles.

The Intercostal Nerves may be injured in fractures of the ribs, and intercostal neuralgia follows pressure on the nerve roots by neoplasms callus fractures of the spine spinal caries aneurysm or osteo-arthritis of the spine Herpes zoster may cause intense intercostal neuralgia

THE NERVES OF THE LOWER EXTREMITY

Anatomy —The lumbosacral plexus is formed by the anterior primary divisions of the lumbar and sacral nerves The root supply of muscles is as follows —

2nd and 3rd Lumbar	Sartorius, iliopsoas, pectineus and adductor longus.
2nd, 3rd and 4th Lumbar	Gracilis and adductor brevis.
3rd and 4th Lumbar	Obturator externus and quadriceps.
3rd, 4th and 5th Lumbar	Adductor magnus.
4th and 5th Lumbar and 1st Sacral	Glutei, semimembranosus, popliteus, quadratus femoris and gemellus inferior

4th and 5th Lumbar and 1st and 2nd Sacral	Tibialis anticus, peronei.
5th Lumbar and 1st Sacral	Flexors of toes, tibialis posticus and abductor hallucis.
5th Lumbar and 1st and 2nd Sacral	Gemellus superior obturator internus, semi-tendinosus and soleus.
1st and 2nd Sacral	Pyriformis, gastrocnemius, interossei and the two adductores hallucis.
1st, 2nd and 3rd Sacral	Biceps and extensors of the toes.

The Obturator Nerve is very rarely injured It may be involved in dislocations of the hip and in a strangulated obturator hernia It is more frequently divided intentionally to relieve adductor spasm in severe spastic paralysis Complete division causes paralysis of all the adductors except part of the adductor magnus

The Anterior Crural Nerve injuries are rare except in gunshot wounds Paralysis of the quadriceps results with anaesthesia over the front and inner part of the thigh and on the inner aspect of the lower half of the leg around the internal malleolus An attempt to suture the nerve should be made

The Great Sciatic Nerve is commonly involved in gunshot wounds, but otherwise only a posterior dislocation of the hip will affect it The whole nerve its internal or external popliteal portions may be injured the last being the most common The injury is usually below the buttock, and so the hamstrings are not affected as their nerve of supply comes off at a higher level Complete division leads to complete paralysis of all muscles of the leg below the knee with absolute loss of sensation except in the area of the long saphenous nerve Flaccid foot drop is present

Treatment consists in the prevention of deformity and accurate suture of the nerve Great care is taken to ensure that the two main divisions are in correct apposition Prolonged massage and electro-therapy must be employed The prognosis is unexpectedly favourable especially in respect of the external popliteal division. If nerve suture fails the resulting paralysis can be greatly ameliorated by suitable arthrodeses and leg irons

SCIATICA is almost always a symptom of pressure on either the great sciatic nerve or the lumbosacral plexus The causes are —

1 Pressure on the nerve roots by subluxations of or osteo-arthritic changes in the spine and sacro-iliac joints by spondylitis deformans by malignant growths or tuberculous disease of the spine by tumours of the cauda equina or the meninges and by herniation backwards of the nucleus pulposus of the intervertebral discs in the lower lumbar spine
2 Pressure on the lumbosacral plexus by the pregnant uterus fibroids ovarian tumours and malignant growths of the pelvic bones prostate rectum or uterus
3. Pressure on the nerve trunk below the pelvis by the dislocated head of the femur aneurysms or new growths.
4 Degenerative diseases of the spinal cord such as tabes and syringomyelia.
5 Diseases of the hip joint.

True sciatic neuritis is unilateral and comes on in attacks which are precipitated by exposure to damp and cold The diagnosis of a true sciatica must *never* be made until an exhaustive examination has eliminated any cause of pressure or tension

Symptoms—Acute sciatica produces severe pain all along the course of the nerve It may be paroxysmal or continuous and the patient avoids any movement likely to stretch the nerve If he walks at all he goes on tiptoe with the knee flexed and hip slightly bent and puts as little weight as possible on that leg The lumbar spine and pelvis are tilted to relax tension on the nerve roots Examination reveals tenderness on pressure over the nerve in the thigh and later, some wasting of the muscles of the calf and of the hamstrings Attempts to straighten the knee when the hip is flexed cause severe pain, and the deep reflexes may be diminished The condition tends to become chronic but an attack rarely persists for more than ten weeks

Treatment consists in the discovery and elimination of the cause The true primary sciatica is treated at first by rest in bed Sedatives will be needed in the acute stage and so violent is the pain in some cases that morphia is required. The limb is most comfortable if a strapping extension is applied to the thigh to minimise movement and irritation and also to stretch the nerve Heat, diathermy and short wave therapy are all useful. Later intractable cases may be benefited by injecting saline into the nerve oxygen into its sheath or by stretching the nerve by manipulation or operative exposure.

The External Popliteal Nerve may be injured in the lower part of the thigh or more commonly as it winds round the neck of the fibula. Paralysis has been known to follow the reduction of an intricate congenital dislocation of the hip of some years duration In complete division there is paralysis of the tibialis anticus the extensor group of the foot and the peronei. The foot is held in the position of equino-varus and voluntary eversion and dorsiflexion are impossible Anaesthesia commonly involves the dorsum of the foot and the lower and outer part of the leg if the lesion is above the origin of its cutaneous branch. The nerve is frequently the site of peripheral neuritis in arsenical, lead or alcoholic poisoning

Treatment consists in early suture splinting and physiotherapy If this fails subastragaloid arthrodesis gives good functional results.

The Internal Popliteal Nerve is rarely injured but may be involved in penetrating wounds or in the forced correction of an old-standing flexion deformity of the knee joint Complete division paralyses all the calf muscles and all the intrinsic muscles of the foot. There is anaesthesia of the sole of the foot of the plantar surface of the toes and of the distal part of the dorsal aspect of the four outer toes There is a tendency to a later development of pes cavus or calcaneo valgus

Treatment consists in early suture splinting and physiotherapy The results are poor but the resulting deformity is not very disabling

Partial injuries of both internal and external popliteal nerves may cause severe causalgia.

The Anterior and Posterior Tibial Nerves are occasionally injured by penetrating wounds and by fractures of the tibia and fibula The results

5 Erythrocyanosis.
6 Cervical rib
7 Poliomyelitis
8 Chronic ulcers
9 Arterial spasm
10 Threatened gangrene

B Of head

1 Retinitis pigmentosa.
2 Ménière s syndrome.
3 Vertigo

C Angina pectoris

D Essential hypertension

II *Visceral Disease*

1 Plummer-Vinson syndrome
2 Cardiospasm
3 Idiopathic dilatation of colon
4 Renal sympatheticotonus
5 Cord bladder

III *Relief of Intractable Pain*

1 Inoperable visceral growths.
2 Painful amputation stumps
3 Painful ulcers.
4 Causalgia

IV *Hyperidrosis*

V *Intractable Dysmenorrhœa*

CARDIOVASCULAR DISEASE

Pain in and pallor of peripheral structures *e.g* fingers and toes are an indication of some embarrassment of the arterial supply to the parts In one group of such diseases the changes in the vessel wall are degenerative and fibrosis and calcification lead to loss of elasticity and narrowing of the lumen in other conditions, however the arterial wall is not diseased but is in a state of spasm the calibre of the vessel being so reduced that peripheral ischaemia results It must be obvious that no operation upon the autonomic system can have any beneficial effect after the arterial wall is permanently damaged by organic changes It is in the vasospastic diseases and the earliest stages of arterial degeneration that sympathectomy serves a very useful purpose

Tests of Suitability—It is right, therefore that we should inquire if any reliable tests are available to differentiate spasm from organic narrowing A number of such tests have been worked out each designed to demonstrate vasodilatation consequent upon temporary sympathetic paralysis. This is measured by the rise in skin temperature as recorded by a sensitive thermometer (thermocouple or oscillograph) Two methods are generally practised first the induction of reflex vasodilatation by immersing one limb in hot water and measuring the temperature

of the other and second, by paralysing vasoconstrictor fibres by injecting 2 per cent novocain into the stellate ganglion ulnar nerve at elbow or median at wrist while the sciatic or external popliteal can be similarly treated. With maximum dilatation the skin temperature should rise to 36° C If under the condition of these tests it fails to reach 30 C then spasm is slight organic constriction marked and sympathetic surgery is unlikely to achieve a favourable result

4 In the Extremities.—Raynaud's Disease has been described on p 176 In the upper limb the sympathetic trunk is divided below the 3rd thoracic ganglion with section of the white rami of 2nd and 3rd thoracic nerves That of the first thoracic must be preserved lest Horner's syndrome develop To prevent regeneration the upper end is dissected up and stitched into the stump of scalenus anticus In the lower limb a lumbar ganglionectomy will be required.

Thrombo-angiitis Obliterans is described on p 284 Sympathectomy should be performed only if tests reveal a marked spasmodic element In all cases operation should be bilateral. Prognosis is far from good.

In Acrocyanosis the pain tenderness swelling and cyanosis of the hands, together with any trophic changes, are usually greatly improved by sympathectomy

In Erythromelalgia redness and pain appear to present a picture quite opposed to Raynaud's disease nevertheless lumbar sympathectomy often gives relief. In Erythrocyanosis a plum-coloured change is seen in the legs in women, chiefly upon the antero lateral surfaces. Later nodular patches appear in the subcutaneous tissues and these break down to form indolent ulcers. For these later manifestations lumbar sympathectomy gives brilliant results

Cervical Rib —Certain cases of cervical rib and of the so-called scalene syndrome (p 364) do not gain relief from rib removal or scalene section Such patients may improve after cervical sympathectomy

Poliomyelitis and Chronic Ulcers both show improvement from sympathetic surgery

Arterial Spasm and Threatened Gangrene.—Apart from thrombo-angiitis obliterans ischæmia and threatened gangrene are usually due to organic disease and not to spasm. Sympathectomy cannot be considered unless tests show a marked degree of spasm

B **Of the Head.**—Resection of the upper cervical ganglion has been performed in an attempt to relieve those most difficult *conditions* retinitis pigmentosa Ménière's syndrome and vertigo In none can the results be claimed as encouraging

C **Angina Pectoris.**—Much work is being done on this subject Although improvement can be expected from removal of the stellate and upper four thoracic ganglia the patient's condition is not conducive to extensive and dangerous surgical procedures especially when paravertebral injections may achieve a similar result

D **Essential Hypertension.**—Provided that organic cardiac and renal disease can be excluded in patients below the age of 50 years fair results may be anticipated after section of the splanchnic nerves in the thorax and of the *cœliac* and upper *two* lumbar ganglia upon

both sides This is a very drastic procedure with a *high mortality but* in carefully selected cases great improvement can confidently be expected.

VISCERAL DISEASE

Plummer Vinson Syndrome.—This disease of women—dysphagia anæmia and atrophy of the mucous membranes of the tongue and pharynx—has been relieved in certain cases by removal of the upper cervical ganglion.

Cardiospasm.—Although section of the left gastric artery has been recommended, the periarterial sympathectomy thus performed gives most discouraging results Regular dilatation is more satisfactory

Idiopathic Dilatation of the Colon.—Since Telford s discovery that spinal anæsthesia cures this condition, lumbar ganglionectomy is no longer indicated.

Renal Sympatheticotonus.—Certain cases of hydronephrosis in which no cause can be demonstrated are believed to be due to achalasia Only such cases as show a marked acceleration in emptying time of the pelvis after intramuscular injection of eserine (gr $\frac{1}{100}$) are suitable for sympathetic denervation. This is performed by a meticulous stripping of the renal pedicle

Cord Bladder—Retention with overflow or large quantities of residual urine without organic obstruction are sometimes due to loss of power in the parasympathetic These conditions are associated with changes in the sacral segments of the cord, often so small as to yield no clinical evidence or at most a small area of anæsthesia around the anal orifice Such patients are greatly improved by resection of the presacral nerve

No good results can be expected from this operation in gross lesions of the cord.

INTRACTABLE PAIN

Inoperable Visceral Growths.—Apart from angina pectoris and dysmenorrhœa sympathetic surgery holds out little hope of relief to sufferers from inoperable internal growths

Painful Amputation Stumps and Ulcers.—In both these conditions appropriate sympathectomy often leads to dramatic improvement.

Causalgia results from an incomplete division of nerves or their involvement in dense scar tissue As a last resort, after all local measures have been tried and failed sympathectomy sometimes brings relief

HYPERIDROSIS

Sweating hardly seems to justify operation but excessive sweat ing may *lead to loss* of employment and acute *mental distress*. Sympathectomy is completely successful in curing this embarrassing condition

INTRACTABLE DYSMENORRHŒA

The position of sympathetic surgery in this disease is discussed on p 855 Suffice it to say here that presacral neurectomy is to be considered only when other measures have failed

R M HANDFIELD-JONES.

CHAPTER XLIV

INJURIES OF BONES AND JOINTS

SURGICAL ANATOMY—Bones.—The bones of the skeleton are divided for purposes of classification into long bones, short bones, flat bones and irregular bones. The long bones are found in the limbs and consist of a shaft and two articular ends. The shaft is a hollow cylinder enclosing a space, the medullary cavity. The walls of the shaft are formed of compact bone lined by a few scattered trabeculæ of cancellous bone which towards the ends become more numerous, the medullary cavity being correspondingly smaller. The articular ends are expanded and consist of cancellous bone enclosed in a thin compact layer and capped on their articulating surfaces with hyaline cartilage. The medullary cavity contains yellow marrow, a fatty tissue with few cells; the interstices of the cancellous tissue are filled with red marrow, consisting of blood spaces and groups of large hæmatopoietic cells.

During the period of growth the articular ends are separated from the shaft by a plate of cartilage, the epiphyseal cartilage. The articular end is then called the epiphysis, the shaft the diaphysis, and the part of the shaft next to the epiphyseal cartilage the metaphysis. Growth in length takes place entirely at the metaphysis, growth in thickness is due to the laying down of new bone on the outside of the shaft by a layer of osteoblasts on its surface. The growing bone is more vascular than that of an adult, and contains a greater proportion of organic material. It can be bent considerably without breaking and may be broken in part of its thickness only; when broken completely the ends tend to be jagged and serrated. The metaphysis where the blood supply is abundant and new bone is being laid down, is the weakest part.

Bone is covered by periosteum, a fibrous limiting membrane which is firmly adherent at the epiphyseal line and at the point of insertion of tendons or ligaments, but is elsewhere loosely attached. The periosteum of a growing bone is more vascular and more easily stripped than that of an adult bone and when raised carries with it the superficial layer of osteoblasts.

The blood supply of the superficial layers of compact bone is carried by small vessels in the periosteum derived from those in the neighbourhood. The shaft is supplied by one or more nutrient arteries, which enter through foramina that are constant for each bone, and divide into two main branches, whose terminations reach the metaphyses. The articular ends receive their supply from a vascular ring, the circulus arteriosus of Lexer, which surrounds the bone at the level of the epiphyseal cartilage and gives off branches both to the epiphysis and to the metaphysis.

The short, flat and irregular bones consist of cancellous tissue enclosed in a layer of compact bone that is thin, except where it transmits stress. The cancellous tissue of flat bones receives the special name of *diploë*.

Joints.—The joints of the body vary considerably in size, strength and in the movements they permit. The capsule is a strong fibrous structure enclosing the joint space and attached to the bones taking part in the

joint, being blended at the point of attachment with their periosteum It is reinforced by ligaments, which in some cases are thickened parts of its wall, in others separate bands outside its wall, and in others lie inside the joint cavity As a rule the portion of the bone included in the joint corresponds *to the epiphysis, but in some joints the metaphysis is also intra-articular.* That portion of the bone which is in contact with the other bones forming the joint is covered by a layer of hyaline cartilage the remainder is covered by synovial membrane The synovial membrane is a vascular tissue lined by a layer of flattened cells and covers the inner aspect of the capsule, any intra-articular ligaments or plates of fibro-cartilage and the bones as far as the edge of the articular cartilage Whenever the articular ends of the bone do not accurately fill the space enclosed by the capsule the inter stices are filled either with fatty pads covered by synovial membrane or as in the knee temporo-mandibular and acromio-clavicular joints, by plates of fibro-cartilage similarly covered. The synovial membrane secretes the synovial fluid, consisting largely of mucin. In a healthy joint this is small in amount the fluid produced being absorbed by the lymphatics such absorption depends upon the movements of the limb and the maintenance *of intracapsular tension by the surrounding muscles. The blood supply of* the synovial membrane is abundant and is derived from the circulus arteriosus.

INJURIES OF BONE

Contusions of bone are caused by the application of force insufficient to cause fracture Two types are described

1 SUBPERIOSTEAL HÆMATOMA is due to a blow upon an exposed bone such as the skull or the tibia. The periosteum is raised, carrying with it a layer of osteoblasts and blood collects between it and the bone. Such a hæmatoma may be absorbed become encysted or be converted into bone

2. CANCELLOUS HÆMATOMA is due to a twisting or bending force, and occurs at the metaphysis of a growing bone Such hæmatomata usually pass unrecognised but they may become infected by blood borne organisms leading to osteomyelitis or they may cause abnor malities in epiphysial growth

Fractures.—A fracture is a sudden and violent solution of con tinuity in a bone Fractures are divided into pathological fractures where weakening of the bone is the dominant factor and trauma is slight or absent and traumatic fractures due to the application of violence or strain to a healthy bone

PATHOLOGICAL FRACTURES may be due to —

1 Congenital diseases of the skeleton. Osteogenesis imperfecta leads to fractures during intra uterine life and early childhood, but the tendency disappears after puberty Fragilitas ossium is a disease, often familial in which the liability to fracture appears after birth and continues into adult life
2. Metabolic diseases affecting the skeleton Scurvy rickets in infancy renal rickets in adolescence and osteomalacia in adult life all lead to a disappearance of calcium from the

bones to an extent that makes them liable to fracture Adenomata of the parathyroid give rise to generalised fibrocystic disease of bone with similar results The common form of rickets does not predispose to fracture

3 General bone diseases of unknown origin—osteitis deformans and myelomatosis
4 Atrophy (osteoporosis) due to old age or wasting diseases
5 Nervous diseases general diseases such as tabes general paralysis of the insane or syringomyelia lower motor neurone lesions such as infantile paralysis
6 Localised atrophy from pressure
7 Inflammatory diseases especially localised gumma
8 Innocent new growths chondroma giant-cell tumour or localised fibrocystic disease i e single cysts
9 Malignant new growths primary sarcoma, or bone metastases of carcinoma arising elsewhere

Many pathological fractures unite readily others slowly while some never join

TRAUMATIC FRACTURES are caused by the application to a healthy bone of violence sufficient to break it Such violence may be *external* either *direct* applied to the bone at the point of injury or *indirect*—bending twisting or compression strains—usually applied in the long axis of the bone or *muscular* the sudden and inco-ordinated con traction of some powerful muscle or group of muscles

CLASSIFICATION OF FRACTURES

A According to the Nature of the Injury to the Bone

Fractures are divisible into two main groups incomplete and complete

1 **Incomplete Fractures.**—The term should be restricted to those which do not involve the whole thickness of a bone it is often ex tended to include fissured fractures which pass right across the bone but in which there is no separation

(*a*) *Fissured Fractures* occur chiefly where the shell of compact bone is thin, that is in flat bones and the articular ends of the larger long bones
(*b*) *Greenstick Fractures* are seen in the long bones of children and are caused by indirect violence. The bone is broken trans versely on the convexity of a curve, and bent or compressed on the concavity (Fig 457)
(*c*) *Cancellous Fractures* are caused by direct or indirect violence applied to the short and irregular cancellous bones and the articular ends of long bones and by indirect violence acting on the metaphysis of a growing bone
(*d*) *Depressed Fractures* are usually seen in the skull but may occur in other flat bones or in large cancellous bones They are due to the application of direct violence over a small area

2. **Complete Fractures.**

(*a*) *Single Fractures* are those in which the bone is broken into two fragments They may be transverse vertical, oblique or spiral.

(*b*) *Comminuted Fractures* in which the bone is broken into several pieces

3 **Impacted Fractures** are complete fractures in which one fragment has been driven into the other producing some degree of interlocking.



FIG. 457

Anteroposterior and lateral views of a greenstick fracture of the radius.

Impacted fractures are usually seen in adults near the articular ends of long bones the shaft being driven into the cancellous tissue of the end

4 **Separation of Epiphyses** occur during childhood and adolescence. In the majority the injury is not a pure separation the line of cleavage passing into the metaphysis juxta-epiphysial fracture being a more accurate description

5 **Complicated Fractures** are those in which other important structures such as vessels or nerves are also damaged.

6 **Fracture Dislocations**, in which the fracture is into or near a joint and accompanied by a dislocation of that joint *e.g.*, Pott s fracture

B According to the Nature of the Violence causing the Fracture

1 **Closed or Simple Fractures** are those in which there is no communication between the surface and the broken ends of the fragments

2 **Open or Compound Fractures** are those in which a wound on the surface communicates with the site of fracture the presence of a

wound does not make the fracture an open one unless it leads to the broken ends of the bone Direct open fractures are those in which the wound of the soft parts lies over the site of injury to the bone they are usually caused by direct violence and the soft parts are lacerated and soiled by dirt or clothing Indirect open fractures are due to perforation of the skin by the end of one of the fragments they are commonly caused by indirect violence and the opening is small not necessarily contaminated and after reduction of the displacement may lie at some distance from the site of fracture

REPAIR OF FRACTURES

When a bone is broken the site of fracture is filled with blood clot the extent of which depends on the separation of the fragments and the degree of laceration of the surrounding tissues. The clot is first converted into granulation tissue indistinguishable from that replacing an ordinary hæmatoma Osteoblasts derived from the bone fragments then invade the granulation tissue and lay down calcium in the intercellular substance Osteoblasts are most numerous under the periosteum less in the endosteum, and scanty in the compact bone therefore calcium is laid down in the outer part of the callus first next in the inner part, and lastly in the middle zone As calcium is deposited the tissue assumes a granular appearance under the microscope and stains deeply with hæmatoxylin This calcified repair tissue is called callus, and the three zones are named external intermediate and internal callus (Fig 458) Calcification commences about the tenth day After three weeks it is sufficient to throw a shadow on an X-ray film, and the callus can be felt clinically as a firm rounded mass at the site of fracture at this time the bone can be bent but the fragments cannot be displaced without some force After four to eight weeks the time depending upon the size of the bone and the age of the patient the callus is sufficiently firm to prevent any movement, and union is said to have occurred.

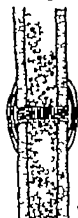


FIG. 458

Diagram showing the three types of callus as described in the text.

At the time of union the fragments cannot be displaced without some violence but the fresh callus may be deformed if it is subjected to a more gradual strain. The repair is made strong and permanent by the gradual replacement of callus by true bone a process called consolidation in the clinical, ossification in the pathological sense. The calcified connective tissue is absorbed by osteoclasts and true bone arranged in Haversian systems is laid down round the blood vessels by osteoblasts. At the same time the callus surrounding the shaft and that filling the space of the medullary cavity between the fragments is removed so that the bone finally resumes a shape and structure approximating to its former state If union has occurred in a position of deformity the new bone is laid down in buttresses that

tend to correct the mechanical weakness inherent in that deformity The process of consolidation requires roughly twice the time necessary for union in any bone It is complete when the site of fracture is no longer palpable or tender and when an X ray shows trabeculation across the site of union.

Large amounts of callus are laid down when there is a large hæmatoma at the fracture line when the fragments are comminuted, and when movement takes place at the site of fracture during union excessive callus formation is common in childhood, especially in fractures near the elbow Little callus is formed when there is scant blood clot and little movement of the fracture as in partial fractures and fractures of bones that are immobilised by others, such as those of the skull and pelvis

Delayed Union may be due to local or general causes Among the first are the conditions described above as leading to diminished callus formation, wide separation of the fragments the interposition of soft parts infection of a compound fracture, or poor blood supply to one or both fragments Among general causes may be mentioned diseases of the skeleton especially rickets osteitis deformans and syphilis and systemic diseases leading to deficiency in all processes of repair Union is said to be delayed if it has not occurred in two months if the delay exceeds a year there is said to be non-union.



FIG 459

Diagram illustrating the formation of a false joint.

A special warning is needed to emphasise the danger of skeletal traction, which has become so popular a method of treatment Over-extension of the limb with wide separation of the fragments is very likely to occur unless careful watch is kept on the fracture during the early part of treatment At the present time this over-extension during skeletal traction is the commonest cause of delayed union.

Non union is of two types In one the ends of the bone are united by repair tissue which however is not converted into callus The *fragments* are little altered in shape or structure but in time tend to become dense and avascular on their free surfaces The term *fibrous union* is often employed to denote non-union that nevertheless gives satisfactory function If the fractured bone is one not subjected to compression or angulation and if the space between the fragments is small and the band of fibrous tissue firm, such a result will give little disability

In the other type of non union a false joint or *pseudarthrosis* (Fig 459) develops between the fragments The ends become smooth dense and avascular and between them a bursal cavity lined by fibrous tissue develops Masses of bone tend to grow round such a pseudarthrosis forming visible or palpable tumours The formation of a false joint is usually due to excessive movement during the process of union

Malunion is union in a position of deformity with shortening

angulation rotation or lateral displacement at the site of fracture Malunion by disturbing the relationship of the joints above and below the fracture to each other interferes with their function and if left uncorrected may lead in time to osteo-arthritic changes

DIAGNOSIS OF FRACTURES

Symptoms and Signs of Fracture.

1 **History**—The nature of the accident will often indicate whether a fracture is likely and its probable site The patient usually knows that he has broken a bone

2 **Interference with Function.**—In all fractures there is some loss of function in the injured part this is less in partial and impacted fractures and in those of one bone in the leg or forearm.

3 **Pain** is present at the site of fracture and is increased by movement Pain in a bone at some distance from the point of application of violence is especially suggestive of fracture

4 **Swelling** round the fracture occurs early and is due to the effusion of blood. Such swelling is usually visible but in a deep-seated bone may be appreciable only by palpation Later the swelling is increased by œdema, which in some fractures notably in those of the lower end of the humerus and the leg and ankle may be extreme

5 **Deformity** or alteration of the normal alignment of the parts, is present except in partial fracture or in fracture of one bone of two The deformity may be one of shortening lengthening, angulation, rotation or lateral displacement or a combination of two or more of these

6 **Abnormal Mobility**—When a bone is broken movement becomes possible in a place where there is no joint. Such abnormal movement may be obvious when the patient attempts to use the limb or may only be discovered on handling the part It is absent in partial and impacted fractures and in those of one bone of two or of a bone otherwise supported

7 **Tenderness** is present at the site of fracture and may be elicited by pressure at this spot or by compressing the injured bone at some distant point.

8 **Crepitus** is produced when the fragments are rubbed together It may occur when the patient attempts to use the part, or may only be noticed upon handling *no attempt should be made to produce crepitus* if it is not noticed during the examination necessary to establish a diagnosis The crepitus of fracture is a coarse grating that is easily felt and may be heard. A softer crepitus is found in osteo-arthritis pleurisy tenosynovitis and surgical emphysema.

9 **Absence of Transmitted Movements.**—The humerus radius and femur are deeply placed in the upper part of their shafts but the head can in each case be felt In fracture movements of rotation applied to the shaft are not translated to the head

Of the above symptoms and signs only four—deformity crepitus abnormal mobility and absence of transmitted movement—are absolute evidence of fracture.

X-ray Examination.—Skiagrams in two planes must be taken of every fracture at the earliest opportunity in order to confirm the diagnosis and demonstrate the position of the fragments. Another pair of skiagrams should be taken after reduction to show whether the position is satisfactory During the course of treatment it may be advisable in many cases to check position and estimate the progress of repair by further examinations. Once the fracture has been reduced and apparatus applied it is inadvisable to risk disturbing the position for purposes of examination such confirmatory X rays must in most cases be taken through the splints or plaster and, if the patient is being treated by traction with a portable apparatus brought to the bedside After union, a final skiagram is advisable to decide whether consolidation is complete

The treatment of a fracture is always a responsible task, and its anxiety is increased by the fact that the majority of legal actions for negligence are concerned with these injuries Skiagrams are available to the patient as well as to the doctor and it is important that these should be taken at the suggestion of the attendant rather than the patient in all cases where fracture is known, suspected or even possible. The fact that X rays have been taken both before and after reduction of the fracture is accepted in law as proof that the patient has been treated with reasonable care and skill, even if the result is poor

TREATMENT OF FRACTURES

The general principles of fracture treatment will be considered under the following headings —

1 The restoration of the fragments to their correct position
2 Maintenance of correct position till union has taken place
3 Protection of the bone after union from stresses likely to produce deformity till consolidation is satisfactory and
4 Preservation of the function of neighbouring muscles and joints during treatment.

The Restoration of Fragments to Correct Position

The replacement of a fractured bone in correct position is called "reduction or setting A fracture should be reduced as soon as circumstances permit because complete replacement is more easily attained before the deformity is fixed by muscular spasm and swelling has obscured the outlines of the parts, and because early reduction places the injured parts at rest and therefore lessens shock Reduction may be performed by one of the following methods —

(1) **Manipulation.**—The fragments are replaced by carefully controlled manual force the exact manœuvre to be employed depending upon the site of fracture and the displacement In most cases the distal fragment is brought into alignment with the proximal

Manipulation may be performed without anæsthesia if the fracture is easily reduced, as when there is a displacement of angulation only and if the patient is not unduly apprehensive Anæsthesia is usually

preferable Gas is suitable where the fracture can be reduced and splints applied within a few minutes For most cases gas allows too short a time and gives insufficient relaxation and local or general anæsthesia should be employed Local anæsthesia is very suitable for the reduction of a fracture since no elaborate technique is required 2 per cent novocain is used the injection of from 10 to 40 c c. into the space between the fragments producing anæsthesia appearing in a few minutes and lasting for one or two hours

B **Gradual Traction.**—Certain fractures notably oblique or very comminuted fractures of the long bones may be reduced by a pull in the axis of the limb but become redisplaced when the pull is relaxed In such cases traction is employed both for the reduction and subsequent fixation Gradual traction is also necessary for the reduction of fractures that are first seen after the lapse of some days, when muscle spasm infiltration of soft tissues and early changes of repair round the fragments make replacement by manipulation impossible

C **Operation or Open Reduction** is necessary when replacement by other means has failed or is impossible. The chief indications for open reduction are the interposition of soft parts between the ends, gross displacement of a detached fragment wide separation in traction fractures failure to secure reduction by manipulation because of the shape of the bone ends or severe concomitant damage to nearby important structures

The Fixation of Fractures

A fractured bone must be retained in correct position after reduction till union has occurred. Such fixation may be external by splints or plaster or internal, by screws wires, plates or pegs controlling the bone itself

Splints fall into two main categories those for fixation and those for traction. The first are used in fractures which when reduced, show little tendency to redisplacement and can be retained either by simple immobilisation and protection, or by maintenance of the limb in some special position the latter are necessary in those fractures which tend to redisplacement after reduction.

Fixation Splints.—The following comprise the splints commonly employed for the treatment of such fractures as can be maintained in position after reduction by fixation alone

(*a*) *Gutter Splints* —These are strips of wood or metal hollowed out on the side that is placed in contact with the limb and made in assorted sizes, ranging from 6 by 1½ in. to 18 by 2½ in Wooden gutter splints are only suitable for splinting one segment of a limb Metal gutter splints may be bent opposite a joint or twisted in their long axis and have therefore a greater range of application they may be made of iron or aluminium, and are usually sold with a covering of felt glued to the concave side Aluminium splints have the advantage that they are translucent to X-rays Two special varieties of gutter splints are Gooch splinting consisting of parallel wood laths glued to a canvas backing which is sold in sheets and is useful for an emergency outfit, since gutter splints of any size and shape can be cut from it,

and Cramer's skeleton wire splints made from galvanised wire in the form of a ladder which can either be applied singly or used to form more complex splints by fastening two or more together by twists of wire or strapping

(b) *Plaster of Paris* is an anhydrous sulphate of lime When dry it is an amorphous white powder when mixed with water it "sets" in from seven to ten minutes to form a homogeneous white mass, possessing considerable strength. For the purpose of making splints some form of fibrous material is always incorporated in the plaster of Paris to give it the necessary tensile strength In practice, plaster bandages are used for all surgical purposes These are made from book muslin into the meshes of which plaster of Paris of the fine variety known as dental plaster is rubbed the bandages are made in widths varying from 2 to 8 in. and are rolled very loosely so that when immersed in water they quickly become saturated.

The Plaster Case is a complete splint enveloping a limb or segment of a limb made by applying plaster bandages in quick succession and rubbing in each layer as it is put on Since plaster expands slightly in setting the case may be applied directly to the skin where there is no risk of the limb swelling afterwards. Alternatively a layer of dressmakers wool is put over the limb either as a complete covering or over subcutaneous bony prominences, before the plaster is applied. Seven or eight layers of plaster bandage form a case of sufficient strength but extra layers should be incorporated at points of special stress

The plaster case affords a completeness and security of fixation that is unequalled by any form of stock splint since it is made to fit the individual limb It can be varied in many ways windows may be cut to allow access to wounds or faradic stimulation of muscles, or larger spaces may be left and bridged by struts of malleable iron. The case may be bisected either immediately or after some weeks, and removed as required for dressings or massage A plaster case should rarely be used in the treatment of a fracture by traction since the pressure of such a rigid material however well padded, is very prone to produce sores

Plaster gutter splints are made by unrolling a soaked plaster bandage and folding the layers backwards and forwards over each other on a surface of wood or glass rubbing the whole together The resulting slab is applied to the limb wet and held with turns of gauze bandage When set the splint is trimmed if necessary and bound round the edges with adhesive strapping

(c) *Special Fixation Splints* designed each for different parts of the body are numerous and each hospital favours its own particular patterns

TRACTION SPLINTS —When the line of a fracture is such that after complete reduction, there is no mechanical security fixation must be obtained either by operation or by continuous traction. Many different splints may be used for traction. The majority consist of a metal skeleton enclosing the limb having at its proximal end some padded surface bearing against part of the patient's body and at its

distal end which lies beyond the limb a point for fixation of the traction cord.

1 *Thomas's Knee Splint* for the lower limb consists of two iron side bars united at the lower end by a broad W to which the extension cord is tied and welded at their upper end to an iron ring set obliquely The ring is padded with felt covered by basil leather and is designed to bear on the tuber ischii (Fig 460)

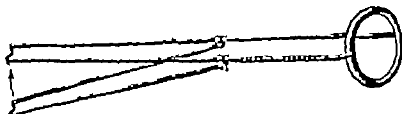


Fig. 460

Thomas knee splint with flexion piece (*Allen & Hanburys.*)

A knee flexion attachment is commonly used with the Thomas's splint This is a replica of the distal half of the splint and is fixed to the side bars by small metal clamps bearing hinges, so that the leg and foot which rest in it, can be set at different angles to the thigh, or knee movements practised

2 *Thomas's Arm Splint* is like the leg splint but made of lighter material. The ring is set at right angles to the side bars and may be hinged.

3 *Robert Jones's Humerus Splint* consists of a ring encircling the shoulder the lower part resting in the axilla being padded and covered with leather Side bars springing from the highest and lowest points of the ring are carried down on the outer and inner sides of the arm to a point 4 or 5 in. below the elbow where they are bent in a W for the attachment of extension cords They are brought up again to the level of the forearm and extended to the wrist where they are united in a broad U (Fig 461)

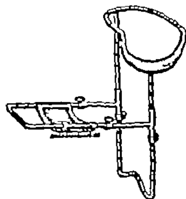


Fig. 461

Robert Jones's humerus splint slightly modified. (*Allen & Hanburys.*)

Many other splints are used for traction and it is often possible, especially in the arm to apply traction effectively without the use of any splint.

Methods of applying Traction to a Limb —The pull may be taken from the surface of the limb either by taking advantage of the contour of the part or by means of adhesive substances fixed to the skin or it may be taken from the bone The first method is known as surface traction, the second as skeletal traction.

Surface Traction —When there is a change in the diameter of a limb such as occurs at a joint, traction may be made from a band

which encircles the limb above its widest part Thus a padded loop may be fixed at the wrist or ankle from which traction is made on the hand or foot The arm or leg may be pulled upon by flexing the elbow or knee and attaching the extension apparatus to a band passing round the forearm or calf. These methods can usually be employed for short periods only and are therefore of limited value

Traction by adhesives is more commonly employed, the substance commonly used being zinc oxide strapping

Application of Strapping Extension to the Leg—A piece of 3-ply wood 3 in. by 3½ in with a hole bored in the centre is used as a spreader This should lie about three fingers breadth below the sole of the

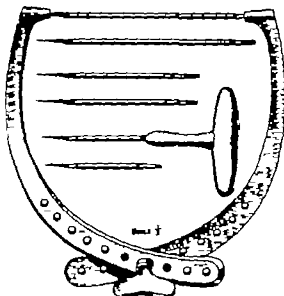


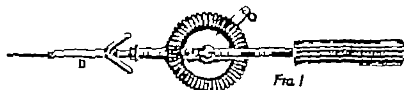
Fig. 468

Steinmann pin apparatus, showing pins, introducer and caliper (*Allen & Hanburys.*)

foot and a piece of 2½-in strapping should be cut of such a length that, with its centre over the spreader the two ends will extend on each side as far as the knee or in the case of high fractures of the femur to the middle of the thigh That portion of the strapping which extends from the spreader to just above the malleoli on each side should be rendered non-adhesive by fastening strips of calico bandage or strapping over its sticky surface The limb is shaved the spreader is held below the foot with its hole in the plane of the malleoli and the two bands of strapping are pulled tight and pressed against the skin in the central axis of the limb on each side The skin bands are kept in position by further sections of strapping which encircle the limb but do not quite meet alternatively a continuous wrapping of elastoplast an adhesive material which being resilient does not constrict the limb or fall into folds, may be applied A strong cord knotted at its proximal end, is passed through the hole in the spreader and

passed over a pulley to take the weights Finally pads of wool are placed between the malleoli and the side bands and the foot and leg are covered with turns of flannel bandage

Skeletal Traction.—Several types of apparatus are used for making traction directly on a bone In each case some part of the instrument must be introduced through punctures in the skin The bone may be pulled by points pressed against its surface by a band passing over a prominence such as the os calcis or by a pin or wire passing through its substance Traction may be made from the distal end of the fractured bone or the proximal end of the bone immediately distal, in which case the force is transmitted through the articular ligaments



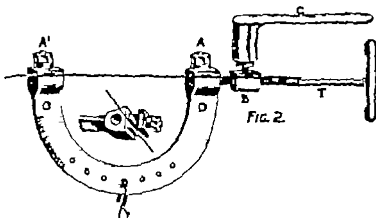


Fig. 463
Apparatus for the insertion of Kirschner's wire. (Allen & Hanburys.)

In general it may be said that pins or wires passed through the bone are most satisfactory since they cannot slip and they allow not only traction but correction of angulation and rotation and that *in most cases* traction through a distal bone is the safest method, since it avoids the risk of infection in the neighbouring joint

Pins for traction are made of plated or rustless steel sufficiently stout to be rigid and are pointed at one end and square at the other (Fig 462) They are driven through the bone either by taps with a hammer or by screwing them in with a handle slipped over the squared end. A caliper with cupped jaws to fit over the projecting points is used for traction.

Kirschner has introduced the use of steel piano wire 19 gauge for the upper limb and 17 for the lower limb in place of pins (Fig 463) The small puncture is almost painless and reduces the risk of infe-
ction

patient should be encouraged to exercise and use the thumb and fingers elbow and shoulder from the very beginning. When the limb must be immobilised, it is often possible to remove part of the splint or one half of a sectioned plaster case to allow access to the limb for physical treatment. Even when direct access is considered unwise use of the part on its protective apparatus can be encouraged thus in a fracture of the tibia and fibula correctly reduced, walking may be allowed in a plaster case applied directly to the skin after the third week and long before this of course on a walking iron. In fractures treated by traction, the apparatus should be so arranged that massage may be applied to the injured segment and the joints moved in this respect skeletal traction has manifest advantages over surface traction

Operative Treatment of Fractures

Operation is employed in the treatment of fractures when other methods have failed or are clearly unsuitable It should in any case only be undertaken by a surgeon conversant with the no touch" orthopædic technique in all its details, and under conditions where these can be rigorously applied. With recent advances in fracture surgery especially the introduction of local anæsthesia and of skeletal traction, the indications for operation have been considerably reduced. Operation may be required for reduction for fixation or for both Operative reduction is required when the shape of the bone-ends is such that they can be fitted together only by separation and exact dovetailing, where small fragments are widely displaced, and where soft parts intervene between the fragments and cannot be disengaged by manipulation Operative fixation is necessary when the fracture cannot be kept in position after reduction by position or pressure alone —in traction fractures in some fractures near a joint where a small fragment is angulated by the pull of a powerful muscle and occasionally in oblique fractures where skeletal traction has failed to give satisfactory reposition. When the fragments tend to separate wire silk or kangaroo tendon are used for fixation when they tend to angulate plates of metal beef bone or living bone fixed by metal or bone screws are employed The advent of penicillin therapy has given greater scope without the fear of possible infection to operative methods

Treatment of Delayed Union Non union and Malunion

Delayed Union.—A search should first be made for the cause of the delay whether this lies in the general health of the patient or in some local error such as malposition of the fragments sepsis in a compound fracture or insufficient immobilisation Any fault discovered should be corrected and it should be remembered that this lies more often in the treatment than in the condition of the patient

Attention should be paid to improving the general health of the patient and especially to providing in the food those factors that are essential to bone repair The diet should include liberal amounts of

fresh vegetables and animal fats. Calcium in the form of calcium gluconate and preparations such as irradiated ergosterol which contain vitamin D should also be administered Fresh air and sunlight stimulate all reparative processes

The most important local treatment is encouragement of function in the fractured segment while retaining the reduced position of the fragments In the lower limb walking in a weight-relieving calliper should be prescribed in the upper use of the limb in a close-fitting plaster case or leather support.

If in spite of long-continued correct treatment there is still inadequate union ten to forty holes according to the size of the bone may be drilled in the indolent repair tissue and the adjacent bone ends through two or three skin punctures The fracture is then again immobilised for a further prolonged period while exercises to preserve the function of the limb without disturbing the fragments are perseveringly carried out

Non union.—If the gap between the fragments is moderate and there is no pseudarthrosis the above methods should be given a trial. If they fail, and in any case where a wide gap or a false joint separates the bone-ends union can only be obtained by operation In some situations such as the upper end of the radius or the lower end of the ulna, the disability caused by non union may be insufficient to justify operative interference An operation for non union demands the exposure of the bone-ends the removal of all scar tissue and sclerosed and avascular callus till healthy bleeding bone is exposed, and the placing of healthy bone surfaces in firm contact with each other Where shortening of the limb does not produce great disability as in the case of fractures of the humerus, the freshened ends of the bone may be wired or screwed together In other cases the gap left after freshening the ends must be bridged by an autogenous bone graft which is usually cut from the subcutaneous surface of the tibia

Malunion.—The treatment of malunion varies with the nature of the deformity the stage of repair and the age of the patient In the old the risks of non-union after correction and the less urgent need for perfect position, should be taken into consideration before active measures are adopted.

Deformities of angulation may be corrected during the period of repair by bending the callus, either forcibly under anaesthesia or gradually by bands attached to the side bars of a traction splint or by a series of plaster cases. After union, and during the period of con solidation, the bone must be refractured and splinted as for a recent fracture in correct position. At a still later period, alignment should be corrected by dividing the bone with an osteotome at a point immediately above or below the fracture and fixing the limb in correct position.

Deformities of shortening, lateral displacement or rotation can only be satisfactorily corrected by operation The site of fracture must be exposed, callus chiselled away the original fracture planes exposed and the ends brought into correct relationship and the position maintained by the appropriate form of splinting or skeletal traction.

Even small degrees of malposition are of serious import in fractures near or involving joints, where the contour of the joint surfaces and their alignment in relation to the transmission of force along the limb must be correct if function is to be preserved. In recent cases showing malunion, the fracture should be reconstructed and the fragments replaced by open operation. After repair has taken place in the deformed position a new articulating surface will have been formed by repair tissue if the movement in the joint is free and painless, but the alignment unsatisfactory the latter should be corrected by osteotomy if the new joint is painful arthrodesis provides the only remedy

Treatment of Compound Fractures

The essential difference between a compound and a simple fracture is that in the former micro-organisms have access to the site of injury which in the latter is sterile In indirect compound fractures the wound is usually clean-cut and little contaminated. In direct compound fractures the soft tissues are lacerated, often to a severe degree and pieces of cloth, earth, grease, and other foreign matter are carried into the depths of the wound the bone is usually contaminated, and fragments may be extruded or even lie loose in the clothing In road accidents the soiling may be extreme and anaerobic organisms such as the bacilli of gas gangrene and tetanus may be present

Bone being unable to undergo the ordinary changes of inflammation, has *little resistance to bacterial invasion* *If infection becomes established* in a compound fracture, loose fragments die and the ends of the shaft and the larger fragments undergo a septic osteitis, leading to the death and subsequent separation as sequestra of portions of their substance. Since the element of tension in a closed space does not exist a true osteomyelitis such as occurs in an uninjured bone due to infection by the blood stream is uncommon but may arise leading to wide necrosis of the bone metastatic abscesses or death from pyæmia. Apart from its effects upon the injured bone sepsis in a compound fracture leads to the formation of granulation tissue in place of callus so that non-union is common and delayed union the rule while the new bone that is thrown out is weak and porous

The most important point in the treatment of a compound fracture is therefore the prevention or elimination of sepsis Immediately after injury the micro-organisms in the wound are in the foreign matter or upon the surface of the tissues and the wound is said to be contaminated after twenty four hours they have multiplied and established their hold and the wound is infected.

In the case of an indirect compound fracture with a small puncture wound, it is sufficient to shave and cleanse the skin round the wound, apply an antiseptic dressing correct the position of the fracture and immobilise the limb on a splint The dressing should be changed *twice daily till it is clear that no infection has arisen* If a spike of bone is protruding from the wound it should be carefully cleaned before it is reduced by manipulation

In direct compound fractures operation is always essential. The

technique is that for all wounds as laid down in Chap VII p 124 The use of both parenteral and local penicillin has become routine practice in the treatment of compound fractures Thanks to its bactericidal powers even completely separated fragments of bone may be left in situ if sufficiently large to be of value as a graft between bone ends but small loose pieces of bone are removed and soiled bone surfaces carefully trimmed with sharp bone-cutting forceps The fracture is reduced and the limb immobilised in plaster

The recent advances made in penicillin and sulphonamide therapy have made it possible for much earlier operative interference in fractures which show signs of delayed union Here again very careful surgical technique is essential and bone grafting or plating can be performed with much less risk of stirring up latent infection

INJURIES OF JOINTS

Joints, like bones may be injured by *direct violence* applied to the joint itself by *indirect violence*—strains of rotation, lateral bending or compression applied to the limb as a whole or by *muscular violence*. Direct violence usually gives rise to penetrating wounds or contusions indirect and muscular violence to sprains internal derangements and dislocations.

Penetrating Wounds of joints are usually caused by sharp objects —knives, nails cutting tools or broken glass They may also be caused by motor accidents or bullets, and in these cases are usually accompanied by injury to the bones forming the joint Penetrating wounds commonly involve the larger and more exposed joints the knee more often than any other The joint is swollen and glairy synovial fluid may be recognised in the discharge from the wound. Their chief importance is that they present a path by which infection may enter the joint

Contusions are the result of a blow over the joint The overlying structures capsule and synovial membrane are bruised or torn in varying degrees Synovial fluid, usually mixed with blood, is poured out, distending the joint cavity Local bruising and swelling are seen at the point of injury which is also tender on pressure and painful during movements which stretch the damaged structures Another type of contusion is caused by strains of compression which jar the opposed articular surfaces against each other Such injuries are often accom panied by sprains of ligaments but the chief damage is sustained by the articular cartilage which becomes swollen and opaque at the points of impact There is effusion into the joint but no evidence of injury on the surface

Sprains are caused by indirect violence which forces the joint in some direction beyond its normal limits The capsule is stretched or torn, and ligaments are ruptured, partly or completely or in some cases detached at their insertions with a superficial flake of bone While the damage falls chiefly on the fibrous structures the synovial membrane is usually lacerated to some extent

Even small degrees of malposition are of seriou[illegible] near or involving joints, where the contour of th[illegible] their alignment in relation to the transmission of [illegible] must be correct if function is to be preserved. In [illegible] malunion, the fracture should be reconstructed [illegible] replaced by open operation. After repair has [illegible] deformed position a new articulating surface will [illegible] repair tissue if the movement in the joint is free [illegible] alignment unsatisfactory the latter should be corr[illegible] if the new joint is painful arthrodesis provides th[illegible]

Treatment of Compound Fract[illegible]

The essential difference between a compound a[illegible] is that in the former micro-organisms have access [illegible] which in the latter is sterile In indirect compound [illegible] is usually clean-cut and little contaminated. I[illegible] fractures the soft tissues are lacerated often to a[illegible] pieces of cloth, earth, grease and other foreign mat[illegible] the depths of the wound the bone is usually conto[illegible] ments may be extruded or even lie loose in the [illegible] accidents the soiling may be extreme and anaerob[illegible] as the bacilli of gas gangrene and tetanus may be pre[illegible]

Bone, being unable to undergo the ordinary changes [illegible] has little resistance to bacterial invasion. If infection [illegible] lished in a compound fracture loose fragments die a[illegible] the shaft and the larger fragments undergo a septic [illegible] to the death and subsequent separation as sequestra [illegible] their substance Since the element of tension in a clo[illegible] not exist, a true osteomyelitis, such as occurs in an uninju[illegible] to infection by the blood stream, is uncommon but may [illegible] to wide necrosis of the bone metastatic abscesses or death f[illegible] Apart from its effects upon the injured bone sepsis in a[illegible] fracture leads to the formation of granulation tissue in plac[illegible] so that non union is common and delayed union the rule whil[illegible] bone that is thrown out is weak and porous

The most important point in the treatment of a compound [illegible] is therefore the prevention or elimination of sepsis Immediat[illegible] injury the micro-organisms in the wound are in the foreign [illegible] or upon the surface of the tissues and the wound is said [illegible] contaminated after twenty four hours they have multiplied [illegible] established their hold and the wound is infected

In the case of an indirect compound fracture with a small punct[illegible] wound, it is sufficient to shave and cleanse the skin round the wou[illegible] apply an antiseptic dressing, correct the position of the fracture a[illegible] immobilise the limb on a splint. The dressing should be change[illegible] twice daily till it is clear that no infection has arisen If a spike o[illegible] bone is protruding from the wound it should be carefully cleaned before it is reduced by manipulation.

In direct compound fractures operation is always essential The

technique is that for all wounds as *laid down in Chap VII p 124* The use of both parenteral and local penicillin has become routine practice in the treatment of compound fractures *Thanks to its* bactericidal powers even completely separated fragments of bone may be left *in situ* if sufficiently large to be of value as a graft between bone ends but small loose pieces of bone are removed and soiled bone surfaces carefully trimmed with sharp bone-cutting forceps The *fracture is reduced and the limb immobilised in plaster*

The recent advances made in penicillin and sulphonamide therapy have made it possible for much earlier operative interference in fractures which show signs of delayed union. Here again very careful surgical technique is essential and bone grafting or plating can be *performed* with much less risk of stirring up latent infection

INJURIES OF JOINTS

Joints like bones may be injured by *direct violence* applied to the joint itself by *indirect violence—strains of rotation, lateral* bending or compression applied to the limb as a whole or by *muscular violence.* Direct violence usually gives rise to penetrating wounds or contusions indirect and muscular violence to sprains internal derangements and dislocations.

Penetrating Wounds of joints are usually caused by sharp objects —knives nails, cutting tools or broken glass They may also be caused by motor accidents or bullets and in these cases are usually accompanied by injury to the bones forming the joint. Penetrating wounds commonly involve the larger *and more* exposed *joints* the knee more often than any other The joint is swollen, and glairy synovial fluid may be recognised in the discharge from the wound. Their chief importance is that they present a path by which infection may enter the joint.

Contusions are the result of a blow over the joint The overlying structures capsule and synovial membrane are bruised or torn in varying degrees Synovial *fluid, usually mixed* with blood, is poured out distending the joint cavity Local bruising and swelling are seen at the point of injury which is also tender on pressure and painful during movements which stretch the damaged structures Another type of contusion is caused by strains of compression, which jar the opposed articular *surfaces against* each other Such injuries are often accom panied by sprains of ligaments but the chief damage is sustained *by the* articular cartilage which becomes swollen and opaque at the points of impact There is effusion into the joint but no evidence of injury on the surface

Sprains are caused by indirect violence which forces the joint in some direction beyond its normal limits The *capsule* is stretched or *torn and ligaments* are ruptured, partly or completely or in some cases detached at their insertions with a superficial flake of bone. While the damage *falls chiefly* on the fibrous structures the synovial membrane is usually lacerated to some extent

The joint becomes distended with fluid, and signs of local injury swelling and bruising, appear over the damaged ligaments Tenderness on pressure and pain on movement are accurately localised to the point of injury Voluntary movements of the joint are impaired, and, when important ligaments have been torn across abnormal mobility may be found.

Internal Derangements, widely interpreted, include the tearing of intra-articular ligaments. The term is usually limited to the displacement of some intra-articular structure between the opposing surfaces of the bones forming the joint causing mechanical locking Since the only structures which can be so displaced in a normal joint are the intra-articular menisci and folds of synovial membrane these injuries are limited to the knee sterno-clavicular and temporo-mandibular joints

During some extreme active or passive movement, a sudden pain, often accompanied by the sensation of a click, is felt in the joint. The joint is found to be swollen and its movements in some directions are arrested by a firm but resilient block. By some manipulation the impacted body can usually be dislodged often with a recognisable snap restoring immediately the full range of movement.

Loose Bodies which develop in a joint may be caused by pieces of bone or cartilage which have been separated as a result of trauma or they may have been extruded into the joint as a result of the condition known as osteochondritis dessicans This condition which occurs most commonly in the knee joint and more particularly on the inter condylar aspect of the internal condyle is due to an avascular necrosis some cases may be associated with trauma but this is not a necessary factor of the condition Osteochondritis dessicans may affect several joints in the same patient for instance both elbows or both knees and in some cases both the elbows and the knees have been involved. The presence of a loose body in the knee joint gives rise to locking, and the patient may even be aware of its presence and may indicate its position. X ray examination is essential in determining the exact diagnosis and the appropriate treatment

Dislocations.—A dislocation is a complete disjunction of the articulating surfaces forming a joint. Usually the capsule is torn and the articular end of one of the bones has left the capsule through the rent and lies among the surrounding tissues Dislocations are as a rule caused by indirect violence and are more common in those joints whose security depends rather on muscular support than on the shape of bones or the strength of ligaments. They are seen in the middle ages of life in childhood a similar injury will cause separation of an epiphysis and in old age a juxta-articular fracture

A dislocation produces notable deformity of the joint itself usually a flattening where one bone is absent from its normal situation and a prominence where it lies in an abnormal one and of the whole region due to the part distal to the joint being out of its normal alignment In addition there are swelling pain loss of function and limitation of movement in directions that are specific for each dislocation.

SUBLUXATION or partial dislocation may also occur In this the

articular surfaces have lost their normal relationship but are still in contact Stretching or tearing of ligaments is necessary before subluxation can occur but neither articular surface is extruded from the capsule

RECURRENT DISLOCATION —When the mechanism on which the security of a joint depends is imperfectly reconstituted after reduction dislocation is liable to recur with only moderate violence Recurrent dislocations of this type are only common in the shoulder and patella and will be discussed with these regions

PATHOLOGICAL DISLOCATION —A joint may become dislocated without pain, or indeed any symptoms when the articular surfaces are completely or partly eroded and the capsule and ligaments softened or destroyed by disease These dislocations are primarily due to disease of the joint the factor of trauma being slight or absent they cannot therefore be discussed appropriately in the present context

The Repair of Joint Injuries.—The capsule and ligaments consist of bundles of fibrous tissue containing a few elastic fibres When they are torn the space is filled with blood clot which is replaced first by granulation tissue later by connective tissue If this connective tissue bridge is short and firm the injured part will regain its former strength but if the gap between the ends is wide or if the repair tissue is stretched during organisation by undue movement faulty position or distension of the joint with fluid permanent weakness will result

The synovial membrane is richly supplied with blood vessels These dilate in response to injury so that the membrane becomes swollen and hyperaemic and a large amount of synovial fluid richer in fibrin than the normal secretion and containing blood from the torn vessels is poured into the joint The damage to the synovia is made good by the ordinary process of repair if it is moderate the membrane will regain its normal appearance and structure if considerable an excess of fibrous tissue will be formed leading to adhesions limiting movement or in the case of free synovial folds to permanent thickening which may cause internal derangement of the joint. Synovial fluid is absorbed by the subsynovial lymphatics and this absorption is aided by muscular movements and intracapsular tension It is hindered by complete immobility and by wasting of muscles surrounding the joint

The hyaline cartilage covering articular surfaces has no recognisable blood supply except at its periphery and possesses no power of repair by its own tissue When bruised the cartilage first swells and becomes opaque while later its surface layers are disintegrated and cast off Cartilage so thinned becomes worn away by subsequent use of the joint leading to osteo-arthritis. Cuts in hyaline cartilage become partly filled in by ordinary fibrous tissue A severe blow on an exposed surface may lead to the death of the injured portion of cartilage which later becomes separated from the surrounding healthy portions by aseptic necrosis and is finally extruded into the joint as a loose body

The interarticular menisci consist of fibro-cartilage covered on their free surfaces by synovial membrane Tears are repaired by connective tissue If a torn meniscus is replaced early and not disturbed during

the process of healing a close approximation to the normal may be reproduced if however it is not replaced, or is injured again before repair is complete it will become loose or deformed, and liable to be jammed between the articulating surfaces during movement

Principles of Treatment in Joint Injuries

Penetrating Wounds.—A penetrating wound of a joint presents the problem of infection or potential infection. The synovial fluid which is poured out in response to any injury has the active bactericidal power of any inflammatory exudate and can deal with an invasion by organisms small in number or of low virulence When this mechanism fails the infection becomes one in a closed space The fluid then serves as a culture medium and becomes purulent and, till evacuated, prevents the secretion of fresh active fluid the synovial membrane is transformed into granulation tissue. A joint so infected is almost necessarily destroyed as a joint further toxæmia, pyæmia and death may follow

The *treatment* of a penetrating joint wound is therefore similar to that of a compound fracture—excision of the track, and of all soiled and lacerated tissues. If penetration of the synovial membrane is doubtful, no probing or instrumental exploration which may enter an unopened cavity and carry infection from the surface to the deeper parts, should be undertaken. The wound in the skin and capsule is first trimmed and the synovial layer inspected. If an opening is present, which will be indicated by the escape of fluid, its edges should be excised. The joint cavity may then be inspected, any blood clot or foreign matter washed out and the interior well insufflated with penicillin powder The synovial membrane and capsule are closed with interrupted catgut sutures the skin wound is partly closed and a rubber or gauze drain led down to the capsule A full course of parenteral penicillin should be instituted, and if effusion recurs in the joint this should be aspirated (approximately every second day) and penicillin solution instilled into the synovial cavity The average dose for a knee joint would be 50 000 to 100 000 units The limb is immobilised in a splint or plaster till it is evident that infection has not appeared in the joint

Non-penetrating Injuries.—Two conflicting claims must be reconciled On the one hand torn ligaments and intra-articular cartilages require complete relief from strain over a long period. On the other hand, function is necessary for the preservation of movement the avoidance of adhesions, the prevention of muscle wasting and the absorption of fluid which, if allowed to remain, will stretch the torn and even the intact ligaments and injure the periarticular muscles.

In all cases complete rest and pressure with a firm bandage is advisable for the first forty-eight hours after injury in order to arrest the effusion and hæmorrhage from torn structures In the case of contusions and minor sprains use of the joint should be encouraged after this only such movements as stretch the injured parts being discouraged or prevented by apparatus Firm pressure should be

applied by strapping or a crêpe bandage while swelling persists and massage may be given

When important ligaments have been torn more complete immobilisation is necessary in the early stages and more positive measures to relieve strain afterwards which should be continued in the case of the joints of the lower limb for from four to six months The first demands splints or a plaster case *the position for fixation depending* upon the ligament which is injured and the most useful position for the joint should ankylosis or limitation of movement result. Function can often be encouraged even though the joint is completely immobilised thus in the case of dislocation of the knee with rupture of all the important ligaments the whole limb must be immobilised in a plaster case but holes may be cut for daily faradic stimulation of the quadriceps and walking should be encouraged. Later a joint may be used more freely but relieved of strain in certain directions thus after rupture of the internal lateral ligament of the knee a jointed steel and leather case may be worn which will allow anteroposterior but prevent lateral or rotary movement and in slighter injuries the heel of the boot may be raised on the inner side to prevent abduction. Internal derangement should be corrected at once by suitable manipulation thereafter the treatment follows the same lines as that for torn ligaments—maintenance of function combined with relief of strain

Dislocation should be reduced immediately Early movement is very desirable to prevent the formation of adhesions but the extent and direction of this movement will be governed by the joint involved and by the extent of damage to the ligaments and adjacent structures.

A. E PORRITT
R Y PATON

CHAPTER XLV

INJURIES OF THE UPPER LIMB

THE CLAVICLE

FRACTURES of the *shaft* of the clavicle are usually caused by indirect violence e.g blows or falls on the point of the shoulder which compress the bone in its long axis The bone breaks about the middle or at the junction of the middle and outer thirds the line of fracture is either transverse or oblique downwards and inwards often with some comminution (Fig 465) *The displacement is constant the outer fragment is carried downwards, inwards* and forwards by the weight of the shoulder and the pull of the pectoral muscles and overlaps the inner which retains its level or is slightly raised by the sternomastoid attachment by about half an inch The classical signs of fracture—loss of function in the arm and pain swelling tenderness and crepitus at the site of fracture—are present The appearance of the patient with swelling due to the projecting inner fragment at the base of the posterior triangle and the shoulder on the injured side at a lower level or the elbow held up by the opposite hand the head being inclined to the same side is usually unmistakable



FIG. 465
Diagram illustrating the two common positions of fracture of the clavicle

The reduction and fixation of fractures of the clavicle present certain difficulties. Reduction can be effected by the standard method of bringing the distal fragment into line with the proximal one that is by pulling the shoulder to which the outer end is attached outwards backwards and upwards General anaesthesia, whilst facilitating reduction makes the satisfactory application of retentive apparatus almost impossible Local anaesthesia should therefore be used for any early case. By strong traction on the shoulder followed by downward pressure on the inner fragment it is often possible in the case of a transverse or nearly transverse, fracture to obtain complete and stable reduction it is then sufficient to apply two or three bands of strapping across the shoulder from front to back, crossing over the fracture and place the arm in a sling

When reduction is incomplete or if complete is unstable the shoulder must be held in the corrected position until union has commenced All methods of immobilisation of the clavicle should permit use of the shoulder and arm The figure-of-eight bandage controls the fracture and permits early movements but must be carefully

supervised and reapplied every two or three days The patient sits on a low stool and the shoulder is braced well backwards and upwards A large pad of wool is placed in each axilla extending well up in front The bandage which must be at least 4 in wide is passed over the shoulder under the axilla and crossing over to the other shoulder which is similarly bandaged (Fig 466) Where the turns of bandage cross between the shoulder blades a few stitches can be put in to hold them together The arm is supported in a sling and early movements are started

In the "*Newmarket*" method the patient sits on a low stool and the arm on the injured side is abducted to a right angle externally

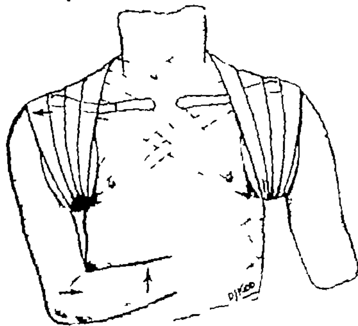


Fig. 466
The bandage pulls the outer fragment backwards and upwards, and the weight of the arm over the axillary pad maintains distraction from the midline. (Watson-Jones)

rotated and extended strongly backwards A wide roll of gamgee is passed under the axilla and over the point of the shoulder and an adhesive felt pad is placed over the inner fragment A length of 3-in. wide adhesive strapping is then passed from the umbilical level vertically upwards over the inner fragment and straight down the back to a corresponding level—the pull firmly holding down the fragment The second strap is passed a short distance further in, overlapping the first The third piece of strapping starts nearer the umbilicus, crossing the others obliquely towards the point of the shoulder round into and through the axilla protected by the gamgee and then up over the point of the shoulder again and down obliquely across the back. A fourth piece of strapping is run round the body at the umbilical level to fix the ends of the other pieces The arm is then dropped into a sling and the patient is able to start using the limb immediately

placed in a sling Massage may be started on the fourth day and movements on the tenth

The Neck is fractured by blows or falls on the shoulder The fracture passes from the scapular notch to the axillary border separating the glenoid and coracoid processes with the capsule of the shoulder joint from the body If the coraco-acromial and coraco-clavicular ligaments remain intact there is little displacement the fracture is suspected only owing to pain and loss of function, and its presence is definitely established by X rays If these ligaments are torn the outer fragment is displaced downwards by the weight of the arm causing flattening of the shoulder and prominence of the acromion This appearance at first sight suggests dislocation of the shoulder but its clinical signs are absent while the deformity is reduced merely by supporting the elbow and recurs when this support is relaxed further the coracoid can be felt to move with the shoulder

When there is no displacement the arm is placed in a sling and massage and movements started early In patients under 45 where displacement has occurred, weight traction with the shoulder abducted to a right angle should be applied for at least four weeks

The Glenoid may be fractured in dislocation of the shoulder a small chip being detached from the lower or anterior margin. It should be suspected when the reduction of a dislocated shoulder cannot be maintained and is a common cause of recurrent dislocation. It can be established only by X rays.

The Coracoid may be broken by the recoil of a gun by the head of the humerus or by muscular action In the uncommon event of displacement the arm should be strapped across the chest in a position of flexion to relax the pull of the muscles attached to the process

The Acromion is broken by direct violence applied to the shoulder There is usually little displacement but voluntary abduction causes pain. The arm should be fixed on an abduction splint for four weeks.

INJURIES TO THE SHOULDER JOINT

Dislocations of the Shoulder—The shoulder has a wider range of movement and depends less for its security upon the factors of mechanical coaptation and ligamentous protection than any other joint It is thus more often dislocated. The great majority of these injuries are due to indirect violence such as falls on the outstretched hand or arm which force the humerus into hyperabduction till the neck is thrust against the acromion. Further abduction forces the head of the bone through the lowest and weakest part of the capsule so that it comes to lie below the glenoid rim on the long head of the triceps Rarely the arm may remain in this hyperabducted position with the head below the glenoid the luxatio erecta but usually it falls downwards (subglenoid dislocation) or the coraco-humeral ligaments becoming tense the head of the humerus is pulled upwards and forwards deep to the subscapularis to lie under the coracoid (subcoracoid dislocation) (Fig 469) or still further forwards under the clavicle on the inner side of the coracoid (subclavicular dislocation)

Less commonly it passes backwards to lie beneath the spine of the scapula (subspinous dislocation) The head of the humerus can lie in the subglenoid position with the arm at the side only if the coraco-humeral ligaments have been torn. The five types of dislocation occur in this order of frequency (1) subcoracoid (2) subclavicular (3) subspinous (4) subglenoid and (5) luxatio erecta All but the first variety are rare



Fig. 469
Subcoracoid dislocation of the shoulder Note the avulsion of the greater tuberosity

A patient with a dislocated shoulder complains of pain inability to use the arm and sometimes numbness in the fingers On removing the clothing an obvious deformity is seen the shoulder is flattened and a sharp angle at the edge of the acromion replaces the usual rounded contour An abnormal prominence appears where the head of the humerus lies under the muscles the elbow is held away from the side of the chest, and the line of the upper arm is seen to lead not to the position of the glenoid but further inwards (Fig 470) Several tests may be used to confirm the diagnosis A ruler laid along the arm can be made to touch the external epicondyle and the acromion The measurement between these two points is less than on the sound side while that taken round the axilla from a point over the upper surface of the acromion is increased. The anterior fold of the axilla is lower than the posterior The head of the humerus can be felt in its displaced position the elbow cannot be brought against the chest wall Careful examination must be made for nerve involvement as in one in seven dislocations there is paralysis as a result of traction injury to the branches of the brachial plexus In addition before reduction is attempted an X ray examination must be made if possible to exclude any complicating fracture



Fig. 470
Subcoracoid dislocation of the shoulder Note the flattening of the contour of the left shoulder and the projection of the elbow from the side (*Watson-Jones*)

Treatment —**Kocher's Method** of reduction is simple and usually succeeds in uncomplicated subcoracoid dislocations It depends upon the stretching of the subscapularis muscle spasm of which is the chief obstacle to replacement There are three steps *Firstly* with the arm abducted to 30 degrees and the elbow at right angles the forearm is used

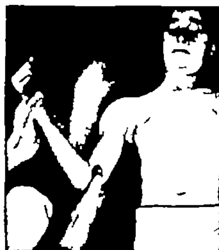


Fig 471



Fig. 472





Fig. 474

the shoulder Traction is pplied. The limb is gently and elbow is brought forward in front of the trunk and the en internall ed. (*Watson-Jones.*)

s ll rotated outwards until on ernal rotation is reached. Se s and upwards across the cher still being fully everted Th bringing the hand on t at any part of this t

When Kocher's method has failed reduction by extension should be performed The patient lies on a couch While an assistant makes counter traction by means of a roller towel round the chest the surgeon abducts the arm to a right angle and pulls steadily in its long axis until the muscles are felt to relax and the head of the humerus comes to lie opposite the glenoid One hand is then placed in the axilla to guide the head of the bone while the other still making traction rotates the arm first inwards and then outwards till reduction takes place When no assistant is available counter-traction may be made by the unshod foot against the chest wall but the foot should never be placed in the axilla.

While early and uncomplicated dislocations may often be reduced without an anæsthetic general anæsthesia should usually be employed not only is this kinder but the muscular relaxation so produced removes the chief obstacle to reduction

After-treatment—The arm is supported by the collar-and-cuff method with a good pad of wool in the axilla and the limb is bandaged to the trunk for a week. A sling only is worn for a further week but active movements of the elbow and shoulder are started Passive movement must on no account be used.

Complications—Fracture of the upper end of the humerus or the scapula may accompany dislocation of the shoulder The only common fracture in this connection is that of the greater tuberosity of the humerus, which is torn off during the dislocation and remains attached to the capsule (Fig 469) Fractures of the anatomical neck and partial fractures of the head are seen in the aged and of the surgical neck in adults while the glenoid rim or coracoid may also be broken A fracture may be suspected when any unusual difficulty is encountered in reduction and is certain when in addition crepitus is felt during manipulation Confirmation and recognition of the exact injury depend on X rays Extension should be used to reduce a dislocation complicated by fracture It will succeed in those involving the greater tuberosity and the intracapsular portions of the head When it fails reposition by operation should be employed immediately

Injury to nerves in the axilla is an infrequent but serious complication of shoulder dislocations The commonest lesion is of the circumflex nerve alone but the posterior or inner cord or even the whole plexus may be damaged The nerves are in most cases bruised or stretched only and partial or complete recovery may be expected if the paralysed muscles are treated by relaxation Operative repair is impractical.

UNREDUCED DISLOCATION—A dislocation of the shoulder can usually be reduced by manipulation often with difficulty up to six weeks from the time of injury and reduction should therefore be attempted up to this time After eight weeks the head of the humerus is so fixed in its new position and the capsule, muscles and even the nerves and vessels have been so altered by the processes of repair that the attempt is dangerous as well as useless Three alternative procedures can then be considered open reduction excision of the head of the humerus or physiotherapy to improve function in the false joint which has

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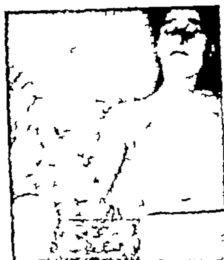


Fig. 471



Fig. 472



Fig. 473



Fig. 474

Reduction of dislocation of the shoulder Traction is applied. The limb is gently and slowly externally rotated. The elbow is brought forward in front of the trunk and the humerus is then internally rotated. (*Watson-Jones.*)

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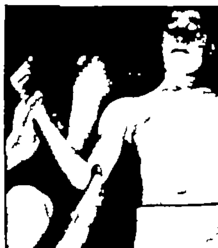


Fig. 471



Fig. 472



Fig. 473



Fig. 474

Reduction of dislocation of the shoulder. Traction is applied. The limb is gently and slowly externally rotated. The elbow is brought forward in front of the trunk and the humerus is then internally rotated. (*Watson-Jones.*)

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After-treatment —The arm is supported by the collar-and-cuff method with a good pad of wool in the axilla and the limb is bandaged to the trunk for a week. A sling only is worn for a further week but active movements of the elbow and shoulder are started Passive movement must on no account be used

Complications —Fracture of the upper end of the humerus or the scapula may accompany dislocation of the shoulder The only common fracture in this connection is that of the greater tuberosity of the humerus which is torn off during the dislocation and remains attached to the capsule (Fig 409) Fractures of the anatomical neck and partial fractures of the head are seen in the aged and of the surgical neck in adults while the glenoid rim or coracoid may also be broken A fracture may be suspected when any unusual difficulty is encountered in reduction and is certain when in addition crepitus is felt during manipulation Confirmation and recognition of the exact injury depend on X rays Extension should be used to reduce a dislocation complicated by fracture It will succeed in those involving the greater tuberosity and the intracapsular portions of the head When it fails reposition by operation should be employed immediately

Injury to nerves in the axilla is an infrequent but serious complication of shoulder dislocations The commonest lesion is of the circumflex nerve alone but the posterior or inner cord or even the whole plexus may be damaged The nerves are in most cases bruised or stretched only and partial or complete recovery may be expected if the paralysed muscles are treated by relaxation Operative repair is impractical

UNREDUCED DISLOCATION —A dislocation of the shoulder can usually be reduced by manipulation, often with difficulty up to six weeks from the time of injury and reduction should therefore be attempted up to this time After eight weeks the head of the humerus is so fixed in its new position and the capsule muscles and even the nerves and vessels have been so altered by the processes of repair that the attempt is dangerous as well as useless. Three alternative procedures can then be considered open reduction, excision of the head of the humerus or physiotherapy to improve function in the false joint which has

formed. The method selected will depend upon the interval that has elapsed since injury the age and occupation of the patient and the amount of disability that is present It must be emphasised that an unreduced dislocation is often compatible with surprisingly good function, and equally that late operation can hardly be expected to produce a first rate result

RECURRENT DISLOCATIONS are usually seen in either healthy young athletes workmen or epileptics After the first injury dislocation is reproduced by very slight violence and even by muscular action thus debarring the patient from any strenuous activity These recurrent dislocations are often the result of direct violence such as a fall on the back of the shoulder The capsule is torn from its attachments to the rim of the glenoid the margin of which may be fractured. These injuries can be treated only by operation Many methods are in use of these that advocated by Nicola is the simplest and is effective in most cases The tendon of the long head of biceps is exposed and divided 1 in below the bicipital groove after stay sutures have been inserted above and below this level. A narrow tunnel is drilled from the lower end of the bicipital groove up to the articular surface of the humerus emerging into the joint at least ½ in. from the articular margin. The proximal portion of the tendon is guided down through this tunnel and resutured taut to the distal portion and to the sides of the bicipital groove while the humerus is in the position of right-angle abduction and internal rotation Alternatively the method advocated by Bankart should be used. It consists of repair of the anterior and inferior part of the capsule with reconstitution of the inferior lip of the glenoid, to which the repaired capsule is firmly sutured with salmon gut



FIG. 475

Diagram illustrating the common sites for fracture of the upper and lower ends of the humerus.

A, fracture of the anatomical neck; B fracture of the greater tuberosity C, fracture of the surgical neck; D supracondylar fracture; E, fracture of the inner epicondyle

CONTUSIONS OF THE SHOULDER JOINT —Falls on the point of the shoulder often lead to bruising of the articular cartilage of the head of the humerus and the glenoid Pain effusion and limitation of movement result and yield slowly to physiotherapy Osteo-arthritic changes are prone to supervene later

THE HUMERUS

The Upper End.—FRACTURES OF THE HEAD AND ANATOMICAL NECK (Fig 475 A) are rare except in the aged They are usually caused by direct violence applied to the shoulder but they may complicate dislocation If the line of fracture is entirely intracapsular the fragments consisting of part or the whole of the head, are frequently detached and lie free in the joint

There is little deformity the outstanding symptoms being loss of function and swelling in the region of the joint The absence of deformity distinguishes this fracture from a dislocation and when the arm is examined *crepitus is noticed in the region of the head* The exact nature of the injury can be determined only by X ray

Since such small fragments if *totally detached can neither be* replaced nor retained in position they must be removed by operation. If their position is satisfactory *the limb should be kept in a sling* for a few days massage being applied to the shoulder At the end of a week moderate abduction may be obtained *by a pad between the* arm and the chest and after three weeks active movements at the shoulder may be started

FRACTURES OF THE SURGICAL NECK are frequently seen in adults (Fig 475 c) The bone is broken either by direct violence or by falls



FIG. 476

Fracture of the surgical neck (abduction type): A, before; B, after reduction.

on the elbow or hand The line of fracture is just above the insertion of pectoralis major and is usually transverse but may be oblique or comminuted. In many cases there is little displacement the fragments being retained by the tendinous fibres which surround the neck Displacement when it occurs results either in the *adduction fracture* where the fracture line is high and there is angulation outwards at the fracture level usually with impaction on the inner side or in the *abduction fracture* (Fig 476) where there is angulation inwards at the fracture level with or without impaction of the fragments on the outer side Much bruising and swelling is present, and the patient cannot use the arm In abduction fractures an external depression may be noticed at the fracture level and the elbow is held away from the chest wall. If there is no impaction it will be noticed that the head of the bone does not follow movement of the shaft the upper end of which may be felt in the axilla Shortening may be demonstrated by the tape-measure

Treatment.—For this purpose fractures of the surgical neck must be divided into three classes. In the first group, which includes the majority of these fractures, displacement is minimal and impaction common. Hence no reduction is required and the arm is immobilised by bandaging it to the chest, a pad of wool having been placed in the axilla. At first an ordinary sling is also applied, but this should be discarded as frequently as possible after the first few days to allow active movements of the shoulder, elbow, forearm, wrist and hand. The bandage, which in well impacted fractures can be omitted, is discarded after ten or twelve days and the arm is supported by a sling only. Active shoulder movements are started as soon as the patient can be persuaded to carry them out. No joint tends to become stiff more quickly or remain stiff longer than the shoulder, so the earlier the patient starts voluntary movements the sooner and fuller will be the recovery. Frequently repeated short periods of voluntary movements give much quicker and better results than prolonged periods twice daily.

In adduction fractures the treatment depends upon the age of the patient and the degree of angulation. In children the deformity must be corrected by traction and abduction and the limb immobilised for three weeks in an abduction frame. In patients over 60 it is inadvisable to immobilise the limb for three or four weeks as the resulting stiffness will prove a grave obstacle to recovery of function. A sling with early active movements will ensure a good recovery. In other patients and where the angulation is marked, 30 degrees or over, traction and immobilisation in an abduction frame for three to four weeks is necessary.

In abduction fractures, impaction of the outer margin of the shaft and the outer part of the head with only slight angular deformity is the most common of all shoulder injuries. There is no need to attempt to reduce the deformity. A sling only is necessary with early movements of fingers, wrist and elbow, followed by active movement of the shoulder after ten days. In unimpacted fractures reduction of the displacement can be obtained by adducting the shaft across the chest and by a hand in the axilla pushing the upper end outwards until the fractured surfaces engage. The limb is then brought to the side and immobilised for three weeks by a sling, with axillary pad and bandage round the chest.

Separation of the Upper Humeral Epiphysis is caused by accidents similar to those responsible for fracture of the surgical neck and occasionally by forcible traction on the arm. The injury is usually a juxta-epiphyseal fracture, a triangular fragment of shaft being detached with the epiphysis. When separation is complete, the displacement of the fragments and the physical signs resemble those of fracture of the surgical neck, except that the crepitus is the soft grating of cartilage. In many cases the separation is partial and the injury can be recognised only by an X-ray.

Treatment follows the lines advocated for fracture of the surgical neck in adults. General anaesthesia is preferable to local for reduction, which must be complete owing to the disturbance of growth which follows malposition. It is sometimes impossible to obtain satisfactory reduction by manipulation and open operation is then necessary. After

replacement the arm is retained by a plaster spica in that position which keeps the fragments in alignment internal methods of fixation should be avoided

FRACTURES OF THE GREATER TUBEROSITY (Fig 475 B) may be due to direct violence or to avulsion Avulsion fractures may occur as an isolated injury or may be a complication of dislocation of the shoulder Where there is very slight or no displacement a sling should be used for a fortnight and active movements must be started at once and practised regularly No passive movements should be attempted

Where the tuberosity is definitely separated it is essential in order to avoid grave disability that the humerus should be abducted to a right angle and externally rotated at least 90 degrees so that the humerus is brought up to the detached fragment This position is maintained in an abduction splint or plaster spica for six or eight weeks until union is sound Active exercises are then started and persisted in for a long time as full functional recovery is slow and takes six months or more In dislocations the tuberosity is widely displaced but returns to position when the dislocation has been reduced



FIG. 477
Fracture through the middle of the shaft of the humerus.

The Shaft.—Fractures of the shaft of the humerus are usually due to direct violence and may involve it at any level they are transverse (Fig 477) or comminuted. Fractures due to indirect violence favour the junction of the middle and lower thirds and are usually oblique The symptoms and signs are obvious and the diagnosis unmistakable Those above the deltoid insertion tend to show an outward displacement of the lower fragment due to the pull of that muscle and those below that level the reverse deformity but the displacement depends in the main on the violence causing the injury

Treatment varies with the type of displacement Transverse fractures may show angulation without other deformity or there may be a considerable overlap Oblique fractures have the most displacement owing to the fact that their sharp extremities become fixed in the triceps muscle End to-end transverse fractures require simple fixation by a light plaster A long plaster slab is applied from just below the axilla down the inner aspect of the arm round the point of the elbow (flexed to a right angle) and up the outer aspect to the shoulder (Fig 478) This plaster is fixed firmly by a bandage A posterior slab from the shoulder down to the back of the wrist may be added The forearm is supported by a sling while in

some cases where the fracture is above the middle of the humerus the plastered limb must be supported in an abduction frame—*60* degrees abduction and 30 degrees forward flexion being the optimum position Transverse fractures heal more slowly than oblique fractures and may require prolonged immobilisation Oblique fractures if there is much displacement should be manipulated into position and put in a plaster as described above They usually heal very quickly Traction is usually unnecessary as slight lateral displacements in *no* way prevent





FIG. 478

Plaster slab and sling for oblique fractures of the shaft of the humerus Fractures with slow union require the immobilisation of frame (inset). (*Watson-Jones*)

a good cosmetic and functional result The oblique fractures are kept in plaster for five to six weeks after which active exercises are started

While the majority of these fractures unite readily delayed union is more common than in any other bone owing to the weight of the arm drawing the fragments apart and possibly to ill judged extension Prolonged immobilisation in a shoulder spica plaster down to and including the forearm should be tried for several months before bone grafting is attempted The most *serious complication* is injury to one of the main nerves usually the musculospiral where it lies in its groove at the back of the humerus The nerve may be concussed contused torn across or compressed by splints or callus As the injury is usually

temporary eight weeks should be allowed to elapse before exposing the nerve If no recovery is apparent or if the signs are increasing operation should be undertaken when the nerve can be freed and sutured if necessary

The Lower End.—Fractures of the lower end are most commonly seen in children below the age of 10 years and are caused by a fall on the outstretched hand or by violence applied directly to the elbow from a fall The first type gives rise to a supracondylar fracture and the latter to intercondylar or T-shaped fractures or to fractures of a part of the bone only

FRACTURES INVOLVING THE WHOLE LOWER END —A *Supracondylar Fractures* (Fig 473 D) are due to a force transmitted along the forearm which pushes the lower end of the humerus backwards. The line of fracture is roughly transverse at or slightly above the level of the olecranon fossa (Fig 479) The lower fragment is pulled backwards and thereafter carried upwards behind the shaft by the action of the triceps and then tilted forwards by the weight of the forearm. The shaft projects forwards into the substance of the brachialis anticus Less commonly the fracture may be partial or complete without displacement



FIG. 479

Supracondylar fracture of the lower end of the humerus in a child showing the typical displacement.

In a typical case the forearm is held at an angle of 135 degrees with the arm all voluntary movements are lost and the wrist is supported by the other hand. The projection of the shaft in the antecubital fossa and of the lower end posteriorly are obvious before swelling and bruising have appeared. On examination it will be seen that the epicondyles and olecranon maintain their normal relationship and that the measurement from the external epicondyle to the styloid process of the radius is unaltered but that the distance from the acromion to the external epicondyle is less than on the sound side These signs serve to distinguish the injury from a dislocation of the elbow Later the bony landmarks are obscured by swelling but crepitus may be detected. In fractures without displacement the measurements are unaltered, but the swelling and bruising should suffice to suggest an injury to the bone An X ray must always be taken

B *Intercondylar or T-shaped Fractures* are more often due to violence applied to the point of the elbow and the backward displacement of the lower fragment is not therefore so common This is a transverse fracture at or about the olecranon fossa from which a vertical fissure runs into the joint The lower end of the shaft is often forced into this fissure thus separating the fragments The clinical picture is similar

to that of supracondylar fracture but the soft parts usually show evidence of injury and bruising is extensive and early The condylar region is broadened and crepitus occurs with every movement

C. *Separation of the Lower Humeral Epiphysis* may occur before the age of 6 years but is a very rare injury The displacement is similar to that in supracondylar fracture

Treatment of Supracondylar Fractures—Early reduction of these fractures is particularly important since swelling appears rapidly and interferes considerably with replacement of the fragments Careful examination for nerve injuries must always be made before attempting reduction A general anæsthetic is always necessary The fragments are first disengaged by gently extending the elbow and traction is then made on the forearm till shortening is overcome The lower fragment is then forced forward into line with the upper and the elbow is gradually flexed. When reduction has been effectually performed the fracture feels reasonably secure the bony points round the joint are in their normal relative positions, elbow movements are free and the carrying angle is equal to that on the other side A posterior plaster slab is applied from the axillary level down to the wrist with the elbow flexed to 120 degrees (Figs 460 to 463) If this amount of flexion causes obliteration of the radial pulse it must be reduced until the pulse can be felt The wrist is supported by a collar-and-cuff sling The circulation must be watched most carefully for the first forty-eight hours and the splints removed if the hand becomes swollen or cold the pulse at the wrist faint or if there is much pain in the forearm or hand. The *after-treatment* is divided into four periods of ten days each during the first the arm is kept in the plaster case during the second it is suspended from the neck by a sling tied round the wrist and the angle of flexion at the elbow is increased daily to a maximum in the third the arm is still kept suspended in full flexion, but relaxed several times a day for voluntary movements and during the fourth active exercises are encouraged in the house but the sling is worn out of doors

In many cases complete reposition cannot be obtained by one manipulation and further manipulations under general anæsthesia will be necessary Until the general alignment is reasonably good this treatment should be adopted and the moulding which follows use will ensure an ultimate result which is in every way excellent If the position after several attempts at reduction remains unsatisfactory it is advisable to let the fracture consolidate wait for six months or a year until the range of movement shows no signs of further improvement and then perform a supracondylar osteotomy The after-treatment is similar to that for a fracture reduced by manipulation.

T-shaped fractures should be reduced in a similar way to the above but after the general alignment has been restored it is necessary to bring the condylar fragments together by lateral compression Traction combined with manipulation and lateral compression of the fragments followed by a posterior plaster slab with the elbow flexed to about 30 degrees short of a right angle gives much better results than open peration with attempts at internal fixation In some cases traction



Fig. 480



Fig. 481



Fig. 482



Fig. 483

Reduction of supracondylar fracture

Traction is applied and while it is maintained the elbow is flexed t 45 degrees above the right angle. Lateral displacement is corrected by direct pressure, and a posterior plaster slab is pplied. (*Watson-Jones.*)

on the fully extended elbow combined with lateral compression of the fragments followed by immobilisation in plaster in the extended position gives good reduction the plaster being removed after four weeks It is not advisable to apply traction by ice-tong callipers on the condyles or by a pin or wire through the olecranon as these methods increase the stiffness in the elbow joint

PARTIAL FRACTURES OF THE LOWER END —Fractures of the condyles are caused by direct violence and by falls on the hand, the external being broken more frequently than the internal In children between the ages of 5 and 15 the separated fragment of the external condyle includes the capitellum and an adjacent portion of the trochlea together with a part of the metaphysis above the capitellum and external condyle carrying the external lateral ligament and the common extensor origin Usually the displacement is slight but sometimes the triangular fragment is displaced outwards with marked rotation. Where there is no displacement, the elbow should be kept flexed for three weeks followed by active exercises If displacement is present the fragment may be manipulated back into position should this be unsuccessful open operation is necessary the fragment being guided back into position and sutured with catgut Nails screws or pegs are unnecessary and should not be used



FIG. 484

Fracture of the internal condyle which has been drawn into the joint.

Fractures of the Internal Condyle may be caused by direct or indirect violence The former are often comminuted but there is rarely much displacement In the latter the condyle is snapped by the pull of the internal lateral ligament and is displaced downwards it is sometimes drawn into the joint (Fig 484) The ulnar nerve is frequently involved in this injury or it may become involved later in scar or callus formation Open operation gives the most satisfactory result as it permits examination of the ulnar nerve in addition to dealing with the displaced epicondyle The epicondyle is sutured by two catgut sutures back into position and the ulnar nerve transposed to the front of the joint if necessary

Fractures of the Capitellum are rare injuries caused by direct violence The fragment usually lies loose in the joint and may be considerably displaced but exact recognition of the fracture is possible only by X ray The loose fragment should be replaced by operation and the arm splinted in a position of nearly full elbow flexion In late cases it may be necessary to remove the detached piece of bone

INJURIES OF THE ELBOW JOINT

Dislocations.—The bones of the forearm may be dislocated posteriorly anteriorly or laterally on the humerus *Posterior dislocation* the only common one (Fig 483) is caused by falls on the outstretched hand in a manner similar to that responsible for the supracondylar fractures Dislocation however occurs chiefly in older children or adults There is much pain and all movements are limited The diagnosis presents no difficulty if the case is seen before the appearance of swelling The olecranon projects behind the lower end of the humerus and its distance from the two epicondyles is increased Above the olecranon a hollow can be felt in which the slack triceps tendon is made out On moving the elbow considerable resistance is encountered but no crepitus felt unless the coronoid process is fractured The distance from the lateral epicondyle to the radial styloid process is reduced but that from the acromion to the lateral epicondyle unaltered signs which serve to distinguish a dislocation from a supracondylar fracture When the elbow is swollen these points cannot always be established but the lower level of the backward projection and the absence of crepitus should favour the diagnosis of dislocation

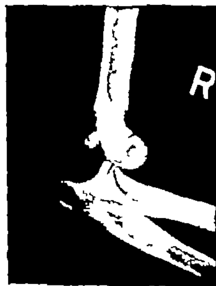


FIG 483
Posterior dislocation of the elbow joint.

Reduction of a backward dislocation is usually very easy the lateral ligaments are torn and the forearm bones slip into position with a dull snap when traction is made on the forearm with the elbow flexed to a right angle It is important to bear in mind that the dislocation is always associated with some degree of injury to the brachialis anticus insertion into the coronoid process This results in stripping of the periosteum (or occasionally a fracture of the coronoid process) with later ossification in the subperiosteal hæmatoma The dislocation should therefore be reduced very gently and the elbow rested for three weeks in full flexion by a collar-and-cuff sling X ray examination after reduction is essential to confirm that reduction is complete and also to exclude fractures of the adjacent bones The fingers wrist and shoulder are exercised while the arm remains in the sling and after the sling is removed active exercises are started and will gradually but sometimes slowly restore full movement to the elbow Massage and passive or forcible movements of the elbow are absolutely contraindicated as they will only cause increase of pain and stiffness with the possibility of the development of myositis

ossificans If the coronoid process is fractured a posterior plaster slab should be used in addition to the collar and cuff

Anterior Dislocation is rare and is usually accompanied by fracture of the olecranon Replacement is easy but the displacement is prone to recur unless the olecranon fracture is secured by operation

Lateral Dislocation is also rare and easily reduced. The after-treatment is that of posterior dislocation

Dislocation of the Radius Alone is nearly always anterior and usually accompanies fracture of the upper third of the ulna The injury is as a rule due to a fall on some projection which forces the head of the radius and lower fragment of the ulna forwards but it is occasionally seen without ulnar fracture after falls on the hand. The orbicular ligament is torn and the head of the radius lies in the supracapitellar fossa The head can be felt in this situation and a hollow appears at its normal position The forearm is held at an angle of 130 degrees and pronated and movements of flexion pronation and supination are considerably limited.

The dislocation can be reduced with little difficulty by traction on the forearm accompanied by pressure over the radial head but recurs immediately unless the elbow is kept fully flexed. The arm should therefore be fixed with the elbow in a position of full flexion and supination and kept in this position for four weeks Extension beyond a right angle should not be attempted till the sixth week

Dislocation of Head of Radius with Fracture of the Upper Third of Ulna —In one type the head of the radius is dislocated forwards with forward angulation of the ulna The displacement is reduced by traction on the limb manipulating the ulna straight and flexing the elbow to a right angle while pressing the head of the radius back into position A plaster is applied from the upper arm down to and, including the hand in full supination with the elbow flexed to a right angle In the other type the head of the radius is dislocated backwards with backward angulation of the ulna Reduction is effected by traction with the elbow fully extended the head of the radius being pushed forwards and the ulna straightened by pressure from behind A plaster is applied with the elbow fully extended from the axilla down to the supinated hand As fractures of upper third of the ulna often heal very slowly the plaster immobilisation may have to be continued for more than the normal four or five weeks

Subluxation of the Head of the Radius (Pulled Elbow) —This injury is seen in young children who have been lifted by the wrist. The head of the radius is pulled partly out of the orbicular ligament which becomes folded in the radio-humeral space There is considerable pain with limitation of flexion and rotary movements. Reduction is readily effected by flexing the elbow while the forearm is alternately pronated and supinated. The elbow should be kept flexed after reduction for fourteen days by suspending the wrist from the neck with a loop of bandage

Tennis Elbow is a form of sprain which occurs as the name suggests most commonly in tennis players but is also seen in fly fishers painters workmen who use hammers, and indeed in any occupation or

sport where quick elbow movements are carried out while the hand is grasping some implement The characteristic symptom is pain in the region of the external epicondyle which occurs whenever the hand is clenched In severe examples the pain is brought on by any grasping movements so that a tea-cup may be dropped involuntarily Upon examination a tender spot is found over or just in front of the external lateral ligament

It appears that tennis elbow may take two forms In one there is an injury to the common origin of the extensors of the wrist and fingers in the other an arthritis traumatic or infective limited to the radio-humeral joint and causing swelling and tenderness of the synovial fringe which separates the bones forming this joint The first type yields in its early stages to physiotherapy and later may be cured by manipulation The second demands rest and the removal of any focus of infection or if the trouble persists excision of the synovial fringe may bring about a cure

Complications of Injuries in the Region of the Elbow Joint

1 **Injury to Nerves.**—Of the nerves round the elbow the ulnar is most commonly injured. In dislocations and traction fractures of the internal epicondyle it may be torn or crushed between the joint surfaces as it may in attempts at reduction of dislocation or of supracondylar fractures in supracondylar fractures it may be stretched over callus during the repair period and in fractures leading to a valgus deformity tension on the nerve in its groove will lead to an ulnar palsy often many years after the accident Crushing and tearing of the nerve should be treated by suture and transplantation to the front of the joint compression or late palsy is relieved by transplantation alone the nerve being laid in a bed prepared in the substance of the common flexor origin The median and musculospiral nerves have also been damaged in injuries in the region of the elbow joint

2. **Ischæmic Paralysis** (Volkmann s Paralysis) —Ischæmic paralysis is due to injury to or obstruction of the vessels at the bend of the elbow It is most commonly seen following the supracondylar fractures of childhood but it may occur in partial fractures or in dislocations The vessels (especially veins) may be injured at the time of fracture or during reduction or they may be compressed by bone fragments œdema or blood clot during the next few hours or still later by splints or bandages The muscular fibres of the forearm muscles especially the flexor group undergo necrosis and are replaced later by fibrous tissue which contracts causing a fixed and claw like hand

The possibility of injury to vessels should be borne in mind when the case is first seen Later the limb must be carefully watched during the first forty-eight hours for evidence of impairment of circulation should the patient complain of pain the pulse become feeble or the hand blue and cold the bandages should be removed immediately and the limb fixed loosely in such a position that the circulation is unhampered When the obstruction is due to swelling round the

fracture necrosis of muscle may often be averted by one or more incisions through the deep fascia.

Once the condition is established the ultimate function of the wrist and hand will depend upon the amount of undamaged muscle tissue At an early stage intensive physiotherapy combined with passive stretching of the shortened flexors and maintenance in an over-corrected position will often achieve more than might be expected The old claw hand type of case can only be improved by operation. That of removal of equal lengths of the shafts of radius and ulna has been displaced by the muscle-slide operation of Max Page in which the internal epicondyle of the humerus with its attached common flexor origin is detached and allowed after forcible overcorrection of the deformity to take up a new position in the forearm

3 **Limitation of Movement.**—In children limitation of movement after injuries to the elbow is usually due to excess callus formation. This complication is especially liable to occur if early passive or forced movements are practised masses of bone are thrown out particularly in front of the joint forming a mechanical block to flexion When the insertion of the brachialis anticus into the coronoid process has been damaged osteoblasts may be liberated into the muscle tissue and an increasing bony mass develop (Fig 480) which if unchecked and untreated will result in grave restriction of movement This constitutes the pathological process known as *Myositis Ossificans* If the development of such a condition is suspected, absolute rest for a long period is essential and the new bone will gradually be absorbed and disappear with a good functional result Operative attempts at removal of this bone only stimulate further bone formation and are therefore contraindicated On this account rest for three weeks is advisable in all cases of severe injury the elbow being kept fully flexed and thereafter only active movements should be encouraged with no massage or passive movements



FIG. 480

Well-marked myositis ossificans in the brachialis anticus.

In adults overproduction of bone is not so common while on the other hand, intra and peri-articular adhesions may limit movements unless these latter are practised early Limitation is usually in the direction of flexion and supination, ch injuries are therefore treated in the flexed and supinat but early voluntary movements should ed whe ot risk the position of a fracture

HE U

Fractures of th ay b ire cular violence Those du r are r the

middle of the sigmoid fossa or comminuted and the degree of separation of the fragments varies considerably Those due to muscular violence occur near the tip and separation is the rule In either case the line of fracture enters the joint There is pain and bruising and the joint is filled with blood-stained fluid and clot Voluntary movements of extension cannot be performed The gap between the fragments can be felt in fractures with separation and crepitus will usually be detected on movement

When there is little or no separation it must be remembered that the triceps tendon insertion has probably been damaged as well The elbow should therefore be immobilised for a fortnight in full extension by an anterior plaster cast extending from the axilla down to the wrist The elbow is gently flexed to a right angle and a sling is worn active exercises being then started In fractures with separation reduction can be effected either by manipulation or by open operation In manipulation the elbow is fully extended and the olecran is manipulated forwards and downwards into position the arm being immobilised in full extension by an anterior plaster case The reduction is checked by X ray examination, and if there is no gap the plaster is kept on for five weeks, after which voluntary movements to increase flexion gradually are started In elderly patients this is the best treatment In younger patients and where X ray examination reveals that a gap still persists in the olecranon open operation is necessary With the patient lying prone with the arm abducted and fully extended on an arm table it is easy to get very accurate apposition of the fragments They are then sutured together with strong catgut or silk by a figure-of eight suture and the triceps tendon is also repaired A light posterior plaster slab is applied for four weeks with the elbow flexed nearly to a right angle

Where the olecranon fragment is small, it may be excised by careful dissection but the triceps tendon must be strongly and accurately repaired. Immobilisation for ten days followed by active movements will lead to a good functional result

Fractures of the Coronoid Process occur as complications of backward dislocation of the elbow and favour redislocation When such an injury is present the elbow should be kept fully flexed for three weeks before movements are allowed

Fractures of the Shaft are usually due to direct violence such as falls on to a projecting surface or blows on the upraised arm Pain and bruising are marked and the fracture is sometimes compound but there is commonly little displacement when the radius is intact

In cases without overlap the general alignment of the arm should be corrected and a light plaster case applied When the ends are separated they should be replaced by manipulation under anæsthesia In many cases operative reduction is required but after such reduction internal fixation should not be needed.

THE RADIUS

Fractures of the Head are usually due to indirect violence applied along the length of the bone such as falls on the hand The head is

splintered against the capitellum and in the commonest type the anterior and outer margin of the head is depressed or slightly detached. The head may be split by irregular cracks without displacement, the fragments being held together by the intact orbicular ligament, or there may be comminuted fractures of the whole radial head with separation of the fragments The pieces may be completely detached and lie loose in the joint cavity

The head of the radius may also be broken by direct violence in which case deformity and separation of fragments are more common

The chief *symptoms* are pain over the site of fracture and limitation of rotary movements and flexion at the elbow Swelling appears locally tenderness is present on pressure and irregularity of the bone may be felt when the forearm is rotated When a fragment lies in the joint the limitation of flexion is more marked.

Cases without displacement should be treated as sprains of the elbow in a sling voluntary movements being started after the third or fourth day By this means adhesions are prevented and the callus is moulded by the orbicular ligament In the majority of such cases perfect function will result even when some slight deformity remains When a portion of the margin of the head is depressed or where the separation of the fragment is only slight conservative treatment in full extension will give excellent results if the orbicular ligament is intact As the radius has been driven upwards at the time of the injury it must be pulled down and an anterior plaster slab applied with elbow fully extended and the forearm supinated When however the fragment is much separated and tilted, excision of the fragment alone if it is small or of the head of the radius when the fragment is large or the bone is comminuted, must be carried out early Limitation of extension is the chief disability following these fractures but this disability can be avoided in most cases by treatment with the elbow fully extended. In children excision of the head of the radius should be avoided if at all possible and conservative treatment adopted, as the epiphysial line will be removed and so the growth of the bone will be seriously interfered with and this will later cause disability in the inferior radio-ulnar joint

The Shaft may be broken by direct violence or by falls on the hand. In the majority of cases when the ulna is intact there is little separation of the fragments, owing to the muscular attachments which ensheath the bone and the only deformity is some loss of the natural curve When the ends are separated the displacement depends upon the nature of the violence and the pull of the muscles particularly the pronators When the radius is fractured with angulation or overriding with the ulna intact there is always a disturbance of the normal relationship in the inferior radio-ulnar joint In fractures above the middle of the shaft the upper fragment is flexed and supinated by the biceps and supinator brevis the lower pronated In fractures below this point both fragments tend to be drawn towards the ulna The most obvious symptoms of fracture of the shaft are loss of grasping and rotary movements and pain and tenderness at the site of injury Pain is produced at this point by pressure on the bone throughout its

length but crepitus may not be obtained owing to the depth of the bone intervention of muscles and absence of gross separation It is often difficult to establish the presence of a fracture of the shaft on clinical grounds alone

In cases without displacement the general alignment of the forearm should be corrected and a plaster case applied with the elbow at right angles and the forearm midway between pronation and supination such a plaster should include upper arm and hand When displacement is present the deformity must be reduced under anaesthesia by traction and manipulation With properly applied counter traction on the upper arm and strong continued traction on the thumb and fingers the fragments can usually be made to engage in the fully reduced position If reduction by this method is un satisfactory open operation under careful aseptic technique is essential The fragments can usually be made to engage firmly and no internal fixation is necessary Plaster is applied from the axilla down to the metacarpal heads and the circula tion in the fingers and their move-ment must be carefully observed for the first twenty-four hours for signs of ischaemia. After reduction a plaster case should be applied In fractures of the upper third of the bone the elbow is flexed and the forearm fully supinated in those of the lower half the midway position between supination and pronation is adopted The plaster must remain on for at least four weeks.



Fig. 487
Fractures of the shafts of both ulna and radius.

The Radius and Ulna

Fractures of the shafts of both bones are commoner than those of either bone alone In adults they are usually caused by direct violence in children they may also be due to this cause but can follow a fall on the hand The level of the fractures is about the middle of the forearm (Fig 487) the radial fracture, however being usually at a lower level than that of the ulna In children the fractures are frequently of the greenstick variety In many cases the ends of the fragments remain in contact or are only slightly displaced and the main deformity is one of angulation the forearm being bent with the concavity on the radial side When separation has occurred the relative position of the fragments depends to a large extent on the direction of the causative violence but in all cases there is a tendency for shorten ing with overlap to take place and for the two bones to be drawn together reducing the interosseous space In fractures of both bones the classical signs will be observed and the diagnosis is evident

When there is no appreciable separation between the fragments, the general alignment of the forearm should be corrected and a plaster



FIG. 488

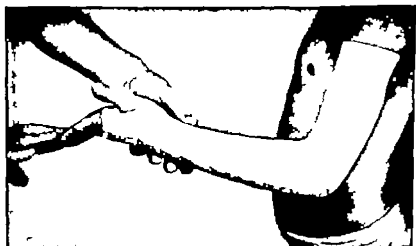


FIG. 489

Fracture of both radius and ulna

FIG. 488.—Strong traction is maintained against the counter-pull of a calico sling. After reduction plaster slab and case are applied. FIG. 489.—Completed plaster for fractures of the forearm bones. The operator is testing for flexion contraction of the fingers, one of the signs of ischæmic contracture of the muscles due to a tight plaster (*Watson-Jones*.)

case applied reaching from above the elbow to the palm of the hand An anæsthetic is not always required When the fragments are separated it is very important that accurate reposition should be

obtained since considerable loss of rotary movements is otherwise very probable and cross union between radius and ulna entirely abolishing such movements will take place in a number of cases Reduction should first be attempted under anæsthesia by traction in the long axis of the forearm with strong counter traction on the upper arm the elbow being flexed to a right angle and pressure on the distal fragments in such a direction as will bring them into alignment for this purpose an X ray to show the exact displacement is essential Should this manœuvre succeed, a plaster case is applied (Figs 488 and 489) and moulded so that the section is oval and not round in this way maintaining separation of the bones from the interosseous space The plaster must extend from the axilla down to the metacarpal heads the elbow being at a right angle Fractures above the middle of the forearm are splinted in elbow flexion and full supination those below in the mid position Subsequent moulding of the fragments and replaster is often necessary especially after swelling has subsided The plaster which must not be replaced at any time by a shorter plaster must remain on for eight to ten weeks and often longer Immediately after the initial reduction a careful watch must be kept on the hand for signs of commencing ischæmia Complaints of pain in the hand by the patient, signs of disturbance of the circulation and limitation of extension of the fingers are evidence which call for immediate action the plaster being at once split longitudinally and opened out When a satisfactory reduction cannot be obtained by manipulation reduction by open operation is essential internal fixation being avoided if possible

FRACTURES IN THE NEIGHBOURHOOD OF THE WRIST JOINT

The region of the wrist is commonly injured by falls on the outstretched hand In childhood the force of such an injury is usually transmitted to some point higher up the limb In adolescence the lower epiphysis of the radius is most likely to separate In adults the radius is strong and dislocations or injuries of the carpal bones are relatively common After middle life the lower end of the radius becomes progressively more brittle and Colles s fracture is the commonest injury

Colles's Fracture is commonly seen in the elderly and is caused by a fall on the outstretched hand The line of fracture passes through the expanded lower end of the radius usually ½ to ¾ in proximal to the wrist joint The classical fracture is oblique passing upwards and backwards but the line may be roughly transverse and varying degrees of comminution are the rule. Impaction is practically always present and usually firm. The styloid process of the ulna is frequently snapped across at its base or the internal lateral ligament may be torn from its tip The lower radial fragment remains attached to the ulna by the triangular ligament and is displaced upwards outwards (i e., radially) and backwards to a varying extent and also rotated outwards and backwards (Fig 490)

There are swelling and pain over the wrist and voluntary movements are lost or much diminished. When viewed from the

back the hand appears deviated to the radial side, the whole wrist is broadened and the head of the ulna abnormally prominent From the side the lower radial fragment and the wrist are seen to project backwards from the line of the forearm making with the flexed fingers, the dinner fork deformity Tenderness will be found over the lower end of the radius and tip of the ulnar styloid and the radial styloid process lies at the same level or higher than the ulnar and more posteriorly Crepitus is absent in most cases While these signs are typical, displacement and deformity may be slight or absent and the fracture can only be suspected by local swelling and tenderness and must be confirmed by an X ray It must be remembered that the lower articular surface of the radius normally looks forwards and slightly inwards as well as downwards

Treatment —Exact anatomical restoration is of the utmost importance in Colles s fracture and is possible in the great majority of cases Impaction should never be allowed to remain except in very old patients. In reduction the points to remember are that the lower fragment must be disimpacted and then pushed downwards and tilted forwards and pushed inwards firmly towards the ulna The disimpaction is obtained by strong traction on the hand this should be sufficient but if it is not while strong traction is maintained the wrist may be further but gently extended The reduction is then carried out by direct pressure on the lower radial fragment which is pushed forwards and inwards and tilted forwards With strong hands applying regulated pressure it should always be possible to get complete anatomical reduction except in cases where much comminution is present The person who reduces the fracture should hold it in position while the plaster is applied. The wrist is slightly flexed in full ulnar deviation A posterior plaster slab is applied from just below the elbow to the metacarpal heads and this is fixed by plaster bandages so that the thumb and fingers are free, but the finger metacarpals are completely immobilised (Fig 491) The patient starts immediately to exercise the fingers elbow and shoulder many times a day The limb is supported in a sling when not in use and the patient is encouraged to use the limb for dressing, eating and other daily duties and gradually increase the activities of the limb The sling should be discarded early The plaster is kept on for four weeks If there was much swelling at the time of reduction the plaster will become loose when the swelling subsides and a new closely fitting plaster must be substituted after ten days Unreduced or malunited Colles s fractures can still be reduced by manipulation up

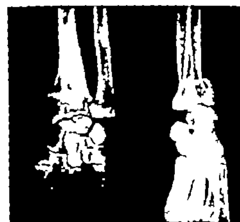


FIG. 490

Two views of a Colles fracture illustrating typical displacement.

to three or four weeks after injury but later and certainly after three months open operation is essential for reduction

Separation of the Lower Radial Epiphysis (juxta-epiphysial fracture) occurs in adolescents The causes are those leading to Colles s fracture in adults and the clinical features are similar except that the displacement of the epiphysis is usually a purely dorsal one without radial deviation or shortening The displacement must be fully reduced by traction and strong pressure There is a distinct tendency for redisplacement to occur Hence these cases are best immobilised after reduction by a plaster case as in the Colles s fracture The plaster must be kept on for three weeks

Reversed Colles's (Smith s) Fracture is caused by a fall on the back of the hand with the wrist flexed The radius is broken at the same

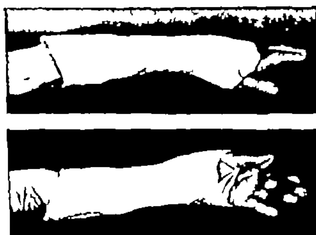


Fig 491

Completed plaster for Colles fracture of radius. It extends over the thumb metacarpal and is closely moulded t the radius. There is no more than strapping in the palm. (Watson-Jones)

level as in Colles s fracture but the line of fracture is usually transverse The lower fragment carrying the wrist is displaced forwards The styloid process of the ulna is often fractured in addition Seen from the back the wrist is broadened and the lower end of the shaft and the head of the ulna form a prominence sloping upwards towards the radial side The hand and wrist lie on a plane anterior to that of the forearm

Smith s fracture should be reduced under local anæsthesia by a manœuvre similar to that employed for the reduction of a Colles s except that the lower radial fragment is pressed very strongly backwards after this has been disimpacted by traction When the lower fragment has been fully reduced, the wrist is immobilised in a plaster case in slight dorsi-extension. The plaster is kept on for four weeks

Chauffeur s Fracture is caused by the backfire of a car which is being started by hand The handle is forced violently against the palm of the operator s hand In most cases a typical Colles's fracture results When however the hand is medially adducted at the time

a chauffeur s fracture may result The line of fracture passes from the lower articular surface of the radius to a point on the outer side of the shaft 1 to 1½ in above the joint. The triangular fragment thus detached is displaced upwards to a varying extent. The dis placement is reduced by pulling the hand first downwards, then by manipulation, the radial fragment being pressed strongly back into position Plaster is applied from just below the elbow to the meta carpal heads with the wrist in the neutral position

If the handle slips from the grasp it will swing round and strike the back of the *forearm* above the wrist, producing a transverse fracture of the radial shaft 1½ to 2 in above the lower end. The lower fragment is displaced forwards This fracture which has also received the name chauffeur s fracture may be caused by other forms of direct violence or in children, by falls. Reduction is obtained by traction and backward pressure on the lower fragment. If as is some-times the case redisplacement occurs readily the fragment may require fixation by open operation.



Fig. 403
Fracture of the carpal scaphoid.

Fractures of the Carpal Bones may be caused by direct or indirect violence Those due to direct violence vary in extent and severity with the force causing them and do not lend them selves to classification. Fractures due to indirect violence usually involve the scaphoid or semilunar

The Scaphoid is broken in adults by falls on the hand The common fracture is trans verse across the middle of the bone and there is little displace-ment The main symptoms are pain on dorsiflexion and radial adduction of the wrist but this is so slight that the condition is often looked upon as a sprain On examination some swelling will be noticed in the anatomical snuff box and direct pressure on the bone is painful. Very careful X ray examination is required. Radiographs in three different planes are necessary and may have to be repeated in cases where tenderness on the radial side of the carpus follows an injury (Fig 403)

If the position is good as it is in the great majority the wrist should be fixed in plaster in 45 degrees dorsiflexion until the fracture is united. The plaster must ensure complete immobilisation of the fragments of the scaphoid and must grip the thumb metacarpal as well as the other metacarpals (Fig 403) The fracture may heal in six or eight weeks but some cases have to be immobilised for six months or more Removal of the plaster and further careful X ray examina tion is essential in deciding whether union is sound. Patients can

usually carry out their full work in the plaster case provided the plaster does not get wet or loose

Excision of the scaphoid or a fragment of it is not followed by good results the function of the hand usually being poorer after than before surgical intervention In cases where union has not been obtained by prolonged fixation in plaster or in those where the fracture has been overlooked at the time of injury the resultant painful wrist can often be materially benefited by exposure of the fracture the removal of sclerosed bone and further plaster immobilisation Subcutaneous drilling of the fractured surfaces or the insertion of small



Fig 493

Bilateral fracture of the scaphoids showing the type of plaster case used. It extends to the metacarpal heads and includes the whole of the first metacarpal. The hand is tightly gripped so that there cannot be any trace of wrist movement, but the plaster in the palm does not extend beyond the transverse skin creases. (Watson-Jones)

bone grafts have not given such satisfactory results as simple roughening of the fracture surfaces

The Semilunar is also broken by falls on the hand and in boxing Symptoms are even less marked than in the case of fractured scaphoid, and use of the hand is continued Under these circumstances the bone may become rarefied and later collapse Cases seen early *should be* treated by eight weeks *fixation* in plaster It is doubtful whether excision in late cases is of any *benefit*

Dislocation of the Wrist and Carpal Bones

Sprains of the Wrist are caused by *twisting* strains and by forced extension or flexion A pure strain is uncommon and should never be diagnosed until an X ray has excluded fracture The joint is swollen and painful and all movements are limited A sprained wrist

should be strapped firmly with adhesive plaster followed after a week by massage and graduated active movements

Dislocation of the Wrist (radio-carpal) Joint is rare and as a rule the result of gross violence The displacement of the hand may be posterior or anterior the former is usual. The deformity in wrist dislocation closely resembles that in Colles s or Smith s fracture and because of the severe pain and considerable swelling which appears within a few moments the clinical distinction may be difficult The normal relation of the two styloid processes in a dislocation should permit its recognition

Reduction is effected by traction under anæsthesia and is usually easy A plaster splint well moulded round the wrist and extending to the metacarpo-phalangeal joints should be applied with the wrist in a position of 45 degrees dorsiflexion It is kept on for six weeks after which massage and movements are given

Dislocation of the Semilunar is much commoner than that of the wrist It usually follows forced dorsiflexion The semilunar is more commonly displaced and rotated forwards so that its concave lower surface faces anteriorly The patient complains of pain and limitation of wrist movements A hollow may be noticed on the back of the wrist proximal to the os magnum and an ill-defined swelling is felt in front under the flexor tendons Grasping movements are weak and pain referred to the distribution of the median nerve is often present An X ray is necessary to establish the diagnosis

The dislocation is reduced by a strong steady continuous pull on the hand without any levering movements of flexion or dorsiflexion This should be continued for at least ten minutes and combined with strong pressure anteriorly over the dislocated bone After reduction is complete traction should be maintained during the application of a dorsal plaster splint which for the first ten days should hold the wrist in 45 degrees flexion This manœuvre should be successful even in the worst cases if the injury is fairly recent In cases of six months standing with a median nerve lesion the bone should be removed. This however will not improve the function of the wrist and therefore is only indicated when the nerve is damaged In cases of one to six months standing reduction may be carried out by open operation combined with the screw traction (distraction) method of Böhler

Dislocation of the other Carpal Bones is usually due to severe direct violence, and the line of separation may involve any of the intercarpal or carpo-metacarpal joints In mid-carpal dislocation the displacement of the distal portion is backwards and is often associated with a fracture of the scaphoid. Such injuries do not lend themselves to any useful classification.

FRACTURES OF THE METACARPALS AND PHALANGES

Fracture of the Base of the First Metacarpal (Bennett s fracture) is due to indirect violence applied in the line of the bone and is most frequently seen in boxers It is essentially a fracture dislocation The fracture passes obliquely downwards from the middle of the articular

surface A small triangular fragment remains articulating with the trapezium and the shaft is displaced upwards outwards and backwards (Fig 494) There are pain and swelling over the base of the thumb



Fig 494
Bennett's fracture.

Reduction is easily affected without anaesthesia by traction and pressure on the base of the shaft The traction must be maintained until the union is sound otherwise the displacement of the shaft will recur The traction is obtained either by skin traction or pin traction from a wire finger splint incorporated in a forearm and hand plaster with the thumb extended and abducted These are retained for four or five weeks (Fig 496) Another type of fracture of the thumb metacarpal usually due to direct violence is commonly seen in which the fracture is a transverse one of the proximal end of the shaft the carpo-metacarpal joint not being involved Reduction is usually easy and stable and is maintained in plaster with the thumb extended and abducted and slightly opposed for three to four weeks



Fig 495
Fracture of neck of fifth metacarpal with typical displacement.

Fractures of the other Metacarpals may follow direct or indirect violence In the first case the fracture is transverse or comminuted and there is much bruising but little displacement With indirect violence (blows on the knuckles) the line of fracture is often oblique and deformity is more common, being one of shortening and angulation backwards In either case there are pain and tenderness over the injured bone and if it is grasped by the knuckle abnormal mobility and increased pain will be noticed. When there is displacement the line of the knuckles will be irregular (Fig 495)

Fractures of the Phalanges are usually due to direct violence and the proximal is most commonly affected The fracture may be transverse or comminuted when displacement is present it takes the form of forward angulation

Fractures without displacement, whether of the metacarpals or phalanges require simple splinting only In the case of the metacarpals a malleable iron splint is the best In the phalanges a slip of metal bent at 45 degrees opposite each interphalangeal joint. When there is displacement

To obtain a full functional recovery the finger must be immobilised for not less than six weeks with the proximal interphalangeal joint

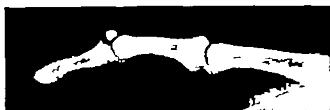


FIG. 500
Mallet finger showing fragment of bone from postero-articular aspect of terminal phalanx.

flexed 90 degrees and the distal joint hyperextended to its limit This is best done by a carefully applied anterior plaster case extending



FIG. 501
Plaster for fracture of base of terminal phalanx and for mallet finger (Farquharson)

from the web to the tip of the finger Even when the injury is of many weeks duration this method, continued for eight weeks or more may give a satisfactory result (Fig 501) Better results can be expected when the tearing of the tendon is accompanied by flake fracture than when the tendon alone is injured Late cases can be treated by operation—either suture of the torn tendon or arthrodesis of the terminal interphalangeal joint

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CHAPTER XLVI

INJURIES OF THE LOWER LIMB AND OF THE SPINE

INJURIES OF THE LOWER LIMB

FRACTURES OF THE PELVIS

FRACTURES of the pelvis fall into two groups those which involve integrity of the pelvic girdle and those which affect outlying portions The first are grave injuries the second in most cases serious only when they are accompanied by lacerations of important soft structures

Fractures of the Pelvic Girdle—The pelvis, formed by the two innominate bones and the sacrum is a strong ring of bone and ligament which transmits the weight of the trunk to the lower limbs and encloses the lower part of the abdominal cavity Fracture is due to considerable violence such as motor accidents falls from a height, or crushing forces A break at one part of the ring is almost necessarily accompanied by one at the opposite part and fractures usually occur at the two weakest places the thyroid foramen in front and the region of the sacro-iliac joint behind In front the line of fracture passes through the horizontal ramus of the pubis at its outer end and the descending ramus at its lowest part. Behind, the sacro-iliac joint itself is only occasionally separated but the typical fracture passes from the iliac crest 1 or 2 in external to enter the joint below less commonly it involves the ala and the first two foramina of the sacrum again entering the lower part of the joint There is usually little displacement but sometimes the side which is fractured behind is displaced upwards

Fracture of the pelvis may be accompanied by damage to any of the pelvic viscera nerves or blood vessels but of these structures only the urethra and bladder are commonly injured. The urethra is torn in its membranous part by rupture of the triangular ligament The base of the bladder which is comparatively fixed may be injured by a similar mechanism or lacerated by fragments of bone The fundus of the bladder if it is full at the time, may be ruptured by the violence of the injury The rectum vagina and pelvic blood vessels being less firmly attached are rarely involved and nerves also usually escape injury unless the line of fracture passes through the sacral foramina

Diastasis of the Symphysis Pubis may occur during childbirth or follow falls on the perineum In the latter case injury to the urethra or base of the bladder is common. The pubes usually spring together after the violence has ceased so that no displacement remains to

indicate the injury which can therefore only be recognised by damage to the urethra, and by extreme pain localised to the symphysis when the iliac crests are compressed or movement is attempted

The *diagnosis* of fractured pelvis is difficult Owing to the severity of the accident the patient is usually shocked, often even unconscious while severe visceral injuries may distract attention from the fracture The cardinal symptom is a sense of insecurity with inability to move the legs or trunk. Pain is felt in the pelvis when movement is attempted and is increased by passive movements of the legs or compression of the iliac crests Tenderness may be found over the fracture of the pubic ramus or near the sacro-iliac joint and irregularity of contour may be noticed on palpation of the ischial and pubic rami from the perineum or through the vagina or rectum There is however no gross deformity unless one side of the pelvis is displaced upwards. In this case the measurement from the umbilicus to the anterior superior spine is decreased on the affected side but other measurements such as Nélaton s line and Bryant s triangle, are unaltered In every case injury to the urethra and bladder should be suspected until it has been excluded and the patient should be warned not to micturate When the urethra is *torn*, blood trickles from the meatus and a swelling appears in the perineum if the patient attempts to pass urine none appears at the meatus but extravasates into the perineum When the bladder is *torn* urine cannot be passed but no blood appears if the rupture is intraperitoneal the abdomen soon becomes distended A catheter should always be passed. When the urethra is torn, the catheter is arrested in the perineum, and a few drops of blood may be withdrawn When the bladder is ruptured the catheter passes easily but no urine, or at most a few drachms of blood-stained fluid is obtained.

Treatment of Fractured Pelvis—The treatment of accompanying visceral lesions (pp 797 and 823) is a matter of prime importance and should be dealt with as soon as possible after the causal accident due allowance being made for allaying shock, which is often severe in these cases In most fractures the displacement is slight and prognosis is little altered by preliminary investigation and treatment of injuries to neighbouring soft parts Reduction is as a rule unnecessary but occasionally gentle manipulation or a short period of leg traction may effect a definite improvement in position The majority of cases simply require careful nursing in bed—preferably on a divided mattress—the pelvis being pulled together either by a firm binder adhesive strapping or if necessary a light plaster

Immobilisation is maintained for a minimum of six weeks although before the end of this time leg movements should be encouraged in the lying position. In all but the worst cases the patient can sit out of bed within two months from the date of injury and should start walking with the aid of crutches As a rule reasonable walking or return to work is not possible under three months

The Acetabulum is fractured by [illegible] olence

The upper and back part of the [illegible] n broken in dislocation of the hip Such an [illegible] jury may be [illegible] when the dislocation is

reduced easily is accompanied by crepitus and recurs after reduction the diagnosis is confirmed by X rays The limb should be fixed in a Thomas's splint in a position of full abduction and weight traction applied for eight weeks A walking caliper is worn for a further ten weeks

The floor of the acetabulum can only be fractured by force transmitted through the femur either along its neck from falls on the trochanter or along the shaft Depending on the degree of violence the socket may be splintered without displacement or the head of the femur driven into the pelvis—so-called *central dislocation of the hip joint*

Walking is impossible and all voluntary movements of the hip limited Pain is felt in the groin and is often referred along the distribution of the obturator nerve Passive movements especially of internal rotation are restricted The leg is shortened the trochanter raised and nearer the midline than its fellow On rectal examination a boggy swelling and occasionally crepitus will be felt on the side wall of the pelvis An X ray will confirm the diagnosis

Skeletal traction with the limb abducted, is the most satisfactory method of obtaining reduction. The extension, through a tibial tubercle pin must be maintained for at least two months after which a weight bearing caliper must be worn for three months The fractured portion of the acetabulum may not be restored to position as the head is pulled out and then open operation will be required

The Crest of the Ilium can be broken by direct violence There is usually little displacement the attached muscles keeping the fragments in position and in any case only minor disability will follow deformity in this situation. It is usually sufficient to support the injured site with bands of elastoplast for three weeks

The Anterior Superior and Anterior Inferior Spines of the Ilium, especially the latter may be broken by muscular violence The accident usually occurs in boys about the age of puberty and leads to localised pain at the site of fracture and limited extension of the hip joint A good X-ray will demonstrate the injury

There is usually little separation and it is sufficient to keep the patient in bed for four weeks with the thigh flexed over a pillow When the spine is completely detached it may be fixed with a screw or bone peg

The Ischium is broken by falls in the sitting position and blows on the tuberosity there is usually little displacement The chief symptom is pain in the buttock, increased by sitting movement of the limb and defaecation Rest in bed for a period of four to six weeks is sufficient treatment but a prolonged period of pain and disability may ensue

The Sacrum may be broken in its upper part in conjunction with fractures of the whole pelvis the line of fracture passing through the upper foramina. In this case involvement of the sacral plexus is common

Fractures of the sacrum alone usually involve the lower half and are due to blows or falls in the sitting position. The line of fracture

is transverse, and the lower fragment is displaced forwards The rectum may be torn or the lower sacral nerves injured The displaced fragment can be pushed back by a finger in the rectum and shows little tendency to redisplacement The treatment consists in rest in bed for six weeks and attention to the bowels

The Coccyx is fractured or displaced by falls in the sitting position There is normally little displacement but the lower fragment or the whole coccyx may be displaced forwards or to one side Pain is experienced in sitting walking and defæcation Any displacement can be reduced by manipulating the fragments between the index finger in the rectum and the thumb on the surface but reduction can seldom be maintained In the majority of cases nevertheless no residual disability exists even when the fragments remain displaced especially if the patient can be kept in bed for a week or ten days. Strapping the buttocks across the top of the natal cleft gives considerable relief from pain in the early stages A few cases however will complain of persistent pain (*coccydynia*) after this injury For them an extensive course of physiotherapy should first be prescribed and, if this fails the injection of some analgesic solution (*e.g* proctocaine) should be tried before excision of the bone is recommended. This latter operation is not difficult but relieves the pain in only about half the cases as it is not essentially the bone which is at fault. The true cause of coccydynia is involvement of the coccygeal sensory nerves in fibrous tissue formed as a result of the primary injury

DISLOCATION OF THE HIP JOINT

The hip joint possesses great natural strength and dislocation is therefore rare Violence applied to the hip in childhood usually leads to a juxta-epiphyseal fracture and in the aged to fracture of the femoral neck. In adults a pure dislocation can occur only if violence is applied when the hips are fully abducted so that the head of the femur is thrust against the lowest and back part of the joint where the capsule is thin and the bony margin of the acetabulum deficient The head of the femur may be forced out of the socket in other directions but only if the acetabular rim is fractured at the same time

Dislocation is due to forced hyperabduction, common instances being the sudden separation of the thighs on an insecure or moving foothold and the fall of a weight on the sacrum of a labourer stooping with legs wide apart The head of the femur is forced through the capsule at its lowest point and thereafter passes up behind or in front of the acetabulum, the direction depending chiefly on that of the force causing the dislocation The Y-shaped ligament nearly always remains intact and governs the position of the limb Four typical dislocations are described two posterior and two anterior

Posterior Dislocations.—(*a*) Gluteal (*b*) sciatic If the head of the femur is forced backwards after leaving the joint it may pass above or rupture the tendon of the obturator internus and come to lie over and behind the acetabulum when the dislocation is called gluteal or it may rest below the intact tendon immediately behind the

acetabulum when it is called sciatic In posterior dislocations the leg is flexed adducted and internally rotated the sole of the affected side resting on the dorsum of the sound foot the knee above the sound knee (Fig 502) Real shortening of 1 to 1¼ in is present and apparent shortening in excess of this. The great trochanter is raised Scarpa's triangle feels empty and the head can be made out under the gluteal muscles All movements are very restricted There is always considerable pain and shock and there may be evidence of pressure on the great sciatic nerve There is less shortening and inversion in a sciatic than in a gluteal dislocation



Fig 502

Traumatic dislocation of the hip joint with typical adduction, internal rotation deformity and shortening (*Watson-Jones.*)

Anterior Dislocations.—(*a*) Obturator (*b*) pubic The head of the femur passing forwards may remain at the thyroid foramen (obturator dislocation) or come out to rest against the horizontal pubic ramus (pubic dislocation) In anterior displacements the leg is flexed, abducted and rotated outwards There is apparent lengthening The head can be felt in Scarpa's triangle and the femoral vessels are displaced inwards Pain may be referred along the distribution of the obturator or anterior crural nerves

Reduction should be carried out immediately under general anaesthesia which must be pushed to the point of complete muscular relaxation The patient is placed on his back on a low couch or the floor and an assistant steadies the pelvis The head of the femur is in each case made to retrace its course to the lowest part of the joint In posterior dislocations the thigh is first fully flexed adducted and internally rotated relaxing the Y-shaped ligament The surgeon then presses firmly downwards on the flexed knee bringing the head below the acetabulum He then rotates the thigh outwards to bring the head towards the midline circumducts the thigh outwards and finally extends it

In anterior dislocations the thigh is first abducted and rotated outwards then pressed downwards in this position rotated inwards while pressure is maintained and finally circumducted inwards and extended In either case the reduction will occur with an audible snap during the movements of circumduction and extension If

manipulation fails after several attempts the dislocation can be reduced by strong traction on a Hawley table but such a method inevitably damages the articular surfaces

After reduction the leg should be immobilised in a plaster spica for six weeks in a neutral position apart from slight abduction, before weight bearing is allowed When there is also a marginal fracture of the acetabulum an extension should be used for four weeks before the plaster spica is applied

Irregular Dislocations are those in which the Y-shaped ligament is torn The head of the femur may pass into any position and the characteristic deformities of the regular dislocations are not seen. Reduction and redislocation are both easier than in the regular varieties and a longer period of recumbency is advisable

FRACTURES OF THE FEMUR

The Upper End

Fractures of the Head of the Femur are rare and are usually seen as complications of dislocation of the hip joint The head may be



Fig. 603
Adolescent coxa vara.

indented or fissured but the displacement is usually so slight that the injury can only be recognised with certainty by X rays Weight traction in a Thomas splint is applied for four to six weeks but daily movements of the joint must also be practised At the end of six weeks a walking caliper is fitted. Osteo-arthritis is an almost unavoidable sequel

Separation of the Upper Femoral Epiphysis (Adolescent Coxa Vara) is a common injury between the ages of 10 and 15 years. It is fully described on p. 1180

Fractures of the Neck of the Femur (Intracapsular Fractures) are typically seen in the aged, and may follow apparently trivial accidents such as tripping over a carpet. *The line of fracture is irregularly transverse through the narrowest part of the neck* (Fig. 604). The amount of separation varies. The deeper reflected fibres of the capsule pass inwards on the front of the neck from the intertrochanteric line towards the head and form strong fibrous bands which may retain some connection between the fragments and prevent displacement. Occasionally the distal fragment is impacted into the head. More commonly there is complete separation and in this case the distal part



Fig. 604
Intracapsular fracture of the neck of the femur

of the neck is displaced upwards by the force of the accident and the pull of the muscles and rotated outwards by the weight of the limb as the patient lies in bed.

In cases without *separation*, or in those with *impaction*, the clinical signs of fracture are few and diagnosis may be almost impossible without X rays which should always be demanded, a good lateral view being absolutely essential. Pain is minimal and the patient *is sometimes able to walk*. On examination there is little *or no shortening* or other deformity and the condition may be thought to be one of osteo-arthritis aggravated by injury. In osteo-arthritis, however there is usually a long history and obvious wasting of the thigh muscles.

Typically the patient is helpless, unable to walk or move the limb, and may be considerably shocked. Pain is felt over Scarpa's triangle and bruising appears over the outer part of the space but this is late in appearance and of moderate degree. The limb lies *fully everted*. Shortening is usually obvious and on measurement may be from ½ to 3 in. The trochanter is raised to the same extent and the iliotibial

band is slack. On moving the limb crepitus is noticed and pain in the groin increased

Union after fracture of the neck of the femur is in all cases greatly delayed and non union is common The reasons for such unsatisfactory repair are the age and poor general health of the average patient atrophy of the neck which has predisposed to fracture and the lack of an independent blood supply to the head of the femur In addition apposition between the fragments is often imperfect and immobilisation incomplete and insufficiently prolonged

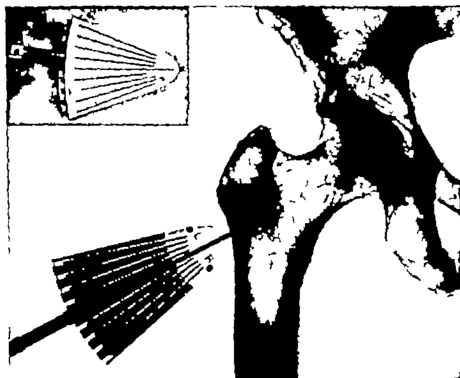


Fig 503

Engel May directing apparatus to facilitate accurate insertion of guide wire. The radiating cannulæ are marked with lead strips The correct line is chosen first in anteroposterior view and then in lateral view after rotating the apparatus through 90 degrees. (Watson-Jones)

In all but the most frail patients the best prospect of bony union in perfect position and ultimate recovery of complete use of the limb is offered by immediate fixation of the fragments After reduction of the deformity by manipulation and if necessary traction, anteroposterior and lateral X ray examination is carried out and, if the position is satisfactory a guide wire is inserted from a point on the outer aspect of the shaft of the femur ½ in below the lower margin of the great trochanter up along the axis of the neck into the upper fragment. The satisfactory placing of this guide wire having been checked by X ray examination in the two planes a Smith Petersen pin is driven along the wire (Fig 505) The correct length of pin must be

carefully calculated Early movements of the hip are encourag from the day after operation but weight bearing is not permitted f at least two months and not until there is X ray evidence of unio The pin is about ¼ in in diameter and is three flanged being Y-shap in transverse section (Fig 506) the narrow blades causing very litt damage to the cancellous bone of the neck while fixing the fragmen firmly

An alternative method is the *Whitman plaster* Under general spinal anaesthesia the fractured limb is extended on a Hawley table t shortening is overcome it is then rotated inwards to bring the dist fragment into apposition with the head and finally abducted to the fullest extent when the broken surfaces are forced together by the leverage of the shaft over the fulcrum of the trochanter resting above on the rim of the acetabulum The limb is maintained in this position by a double plaster spica moulded round the iliac crests from the nipple line to the foot The plaster must extend down to and include both feet After two months the plaster is removed from the foot to above the knee in another month it is removed completely and if X-ray examination shows satisfactory union a month to six weeks is spent moving the limb in bed without retentive apparatus. A weight bearing caliper may then be applied and worn for at least six months



FIG. 506

Smith Petersen pin showing ... cross section ... the blades. (... & Hasberg)

When the condition of the patient does not warrant the risk of anaesthesia and immobilisation in plaster satisfactory correction can usually be obtained by traction The limb is slung in a Thomas's or Hodgen's splint, and a pull of 20 to 30 lbs applied by skeletal traction. When shortening is overcome which should occur within twenty four hours the leg is inverted and slightly abducted. If an X ray then shows satisfactory position, the extending weight may be reduced to 10 lbs *After eight weeks* a light plaster spica is applied extending to just above the knee and worn for a further three months A walking caliper must then be used as describ above

Of these possible methods that of traction is very useful in t elderly type of patient that usually suffers from this injury and is often followed by satisfactory function, although non union is fair common The Whitman plaster is not, on the whole to be advocate non union being almost as common as with traction and the plast being difficult to apply and cumbersome to wear the advantages ov traction are few and the disadvantages many The Smith Peterse pin is consequently becoming more and more popular even in patien of over 60 years of age and many advances in the technique of intr duction both by open operation and by closed methods have recent been suggested. The success of this method however depends on goo X ray photographs accurate reduction of the fracture and caref

and skilled technique in the insertion of the pin In cases of ununited fracture of the neck of the femur an osteotomy should be done just above the level of the lesser trochanter and the shaft displaced medially so that it comes to lie under the head.

In the very old and frail in whom prolonged recumbency is considered hazardous, it may be necessary to abandon any attempt at obtaining union The patient is fitted with a bucket top caliper and allowed to walk after a few days The caliper must be worn permanently since without union the neck of the femur slips up on to the dorsum ilii and gives a flail joint on which walking is almost impossible.

Fractures of the Neck of the Femur in Childhood are commoner than was realised before the general use of X rays The fracture is usually of the greenstick type and the child may continue to walk Coxa vara develops later. Such fractures should be immobilised in plaster for eight weeks in full abduction and a caliper worn for three months after union.



FIG 507
Drawing of the femur showing the usual lines of fracture of the upper and lower ends.

Trochanteric Fractures (Extracapsular Fractures of the Neck) differ in every respect from those of the neck (Fig 507) They are caused by major violence are seen in healthy adults and unite readily The accident is in most cases a fall on the trochanter on a hard surface as in skating The fracture is usually extracapsular behind and partly intracapsular in front It is irregular and almost invariably comminuted the neck, whose under surface bears the very dense calcar femorale being driven into the trochanteric region, breaking it into several fragments Some degree of impaction is usually present

Clinically the patient is shocked, in great pain and unable to use the limb The trochanteric region is bruised and swollen The leg is everted and shortened from 1½ to 2 in The trochanter is raised broadened and nearer the midline than the opposite one but these measurements can rarely be made accurately owing to the swelling The iliotibial band is relaxed. Because of the frequency of impaction some amount of voluntary movement may persist and crepitus is usually absent

Owing to the comminution which is always present trochanteric fractures must be treated by continuous traction. Both limbs are slung in Thomas's splints from an overhead frame at an angle of about 25 degrees abduction The injured limb is in addition flexed 30 degrees at the hip and a knee flexion piece attached to the splint A weight of 10 lbs is attached to the sound limb and one of 30 lbs which may be reduced to 15 lbs, as soon as the position is satisfactory and there is some evidence of union, to the injured limb After eight weeks the splints may be removed and hip movements allowed in bed. One week later the patient is fitted with a walking caliper which must be worn for at least three months.

Fractures of the Great Trochanter or its epiphysis are rare and are usually due to direct violence In most cases there is negligible separation and fixation of the limb in abduction for four weeks is sufficient treatment If the process is entirely separated it should be fixed with a screw or bone peg

Fractures of the Lesser Trochanter are due to muscular violence and are often seen as a complication of extracapsular and inter trochanteric fractures

THE SHAFT

Fractures of the Shaft of the *femur* may occur at any level and may be caused by direct or indirect violence Fractures due to direct violence are usually *transverse* but may be comminuted often to an extreme degree those due to indirect violence are oblique or spiral and usually single The displacement depends to some extent upon the direction of the force causing the fracture In all cases there is a tendency for the lower fragment to be drawn up by muscle spasm, causing shortening and to be rotated outwards by the weight of the leg At the upper end the proximal fragment is flexed abducted and rotated outwards by the muscles inserted into the trochanter At the lower end the distal fragment is tilted backwards by the origins of the gastrocnemius

The patient is helpless and often shocked. Shortening abnormal mobility and crepitus are usually apparent and make the diagnosis of fracture easy but the deep situation of the bone and the swelling which is usually extensive and appears early render an exact recognition of the site of fracture and of the displacement difficult An X ray is required to establish these facts

Treatment —All fractures of the femoral shaft are accompanied by varying degrees of shock and this condition should always receive suitable treatment before more radical measures are attempted During this stage and as a first-aid method the injured limb should be fixed by simple extension (*e.g.*, a clove hitch around the boot) in a large Thomas s knee splint This is preferable to a long Liston splint which does not allow extension.

All fractures of the femoral shaft are reduced by extension. This may be applied manually and held by suitable position as in fractures of the upper and lower thirds it may require strapping or skeletal traction, as in most fractures of the middle third or it may necessitate in the worst or difficult cases operative intervention and mechanical methods

Upper Third.—The situation here is governed by the fact that it is impossible to control the small upper fragment which is flexed by the iliopsoas and externally rotated and abducted by the gluteus medius and obturator internus Hence reduction requires the bringing of the large lower fragment—the rest of the limb—into line with this displaced upper fragment Immobilisation alone is not sufficient as the upper fragment is very liable to become redisplaced unless con tinuous traction is also applied. This can be achieved by using Robert

Jones's abduction splint by a plaster spica with adhesive strapping extension fastened to the raised foot of the bed, the body weight maintaining the traction or by the well leg traction method

Lower Third.—In these fractures there is a large upper fragment and a small relatively uncontrollable lower fragment usually flexed by the heads of gastrocnemius—sometimes to the extent of producing pressure on or actual damage to the popliteal vessels Reduction therefore consists in aligning this large fragment to the lower small one by

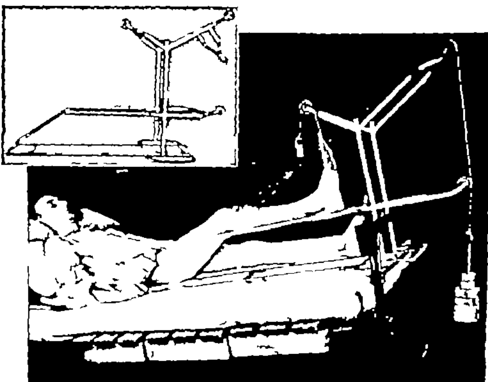


Fig. 508

Bohler Braun splint with tibial skeletal traction for supracondylar fracture of femur The angle of the splint must lie behind the fracture, not behind the knee An alternative lower line of traction is sometimes necessary in supracondylar fractures and can be secured by the four-pulley splint (inset) (*Watson-Jones*)

manipulation and fixation on a Thomas's knee splint or a Braun's splint (Fig 508) traction being maintained either by strapping or by a pin or wire through the tibial tubercle In either splint the knee is held flexed 45 degrees and the foot is supported at a right angle the foot of the bed being raised

Middle Third.—Here treatment depends upon the type of fracture and the displacement. Direct violence usually produces transverse fractures with or without displacement In the former case overlap and shortening occur in the latter only angulation deformity is possible Indirect violence is responsible for the very common oblique or spiral fractures in which both overlap and angulation may occur

and in which the tendency for the sharp ends of the fragments to become entangled in surrounding muscle fibres is very marked

Transverse *fractures without displacement require no reduction* the limb being fixed by strapping extension in a straight Thomas's knee splint and suitable pads or slings applied to the side bars of this to correct any angulation *deformity*

Transverse fractures with overlap may in a few cases be reduced manually if seen early or if they occur in weakly or poorly muscled patients In this case they are treated as above. The majority of such cases however require prolonged extension This may be applied either by strapping extension or by skeletal traction In the former case a weight of some 15 to 20 lbs. is required in the latter up to 30 lbs is applied at first and this can be halved when reduction is effected and only fixation traction is necessary *Skeletal traction* is certainly the more effective It is obtained by a Kirschner wire through either the lower part of the femoral shaft just above the condyles or the tibial tuberosity In view of the possibility of sepsis and also of the liability to stiffness in the knee joint following supracondylar extension, skeletal traction through the tibial tuberosity is preferable The latter *despite* the heavy traction employed, does not cause laxity of the ligaments of the knee joint provided the weight is carefully regulated and reduced when the fracture begins to unite

In either type of *extension due attention* must be paid to adequate counter-extension by raising the end of the bed on blocks and to the prevention of foot drop by the addition of a suitable foot piece to the splint or by fixing the sole of the foot via a short strip of strapping and a cord to a small weight of about 1 lb from a pulley on the overhead Balkan frame

If such extension methods have not proved successful in reducing the overlap within a week or ten days operative reduction must be considered Operative correction however *tends* to increase the fixation of the quadriceps to the femur and so ultimately limit the range of flexion in the knee joint Exposure is obtained by an incision on the outer aspect of the thigh and the fragments are levered into place The fracture being transverse in type no internal fixation should be necessary and the leg is put up with fixed extension on a straight Thomas's splint

In the oblique and spiral types of fracture little can be achieved by manipulation so that extension by one of the above methods is usually essential. Even so the liability of the fragments to become impacted in surrounding muscle makes the possibility of ultimate operative fixation more likely and in these cases some form of internal splintage may be necessary The less internal mechanical fixation the better and it should be remembered that the presence of these retentive fittings in no way lessens the necessity for the usual external splinting and fixation.

In all types of fracture once reduction and immobilisation are obtained every effort must be made *to maintain function* in the rest of the limb The knee joint must be held in a slightly flexed position and must never be allowed to become hyperextended Foot ankle

and, where possible knee movements should be encouraged and faradic stimulation to the quadriceps *in situ* in the splint will do much to prevent the marked muscle-wasting which accompanies these fractures Traction or immobilisation should be maintained for ten to twelve weeks after which if clinical and radiological union are satisfactory the leg should be allowed to move freely in a Thomas's splint the patient still being kept in bed for about four to six more weeks At the end of this time a well fitting walking caliper is applied and the patient allowed to get about At this stage effusion into the knee joint is common but this should rapidly disappear as the tone of the quadriceps is recovered. Weight bearing without the caliper is seldom possible before nine months from the time of the fracture

Fractures of the Femoral Shaft in Children are comparatively common They are due to the same causes as those of adults and present similar clinical features but partial fractures without displacement are more often seen

In new born infants fractures of the shaft of the femur produced during delivery are best treated by being left alone The recommended method of fixing the thigh by flexing it fully on to the baby's abdomen is not necessary In this type of fracture it is astonishing how the most marked displacement corrects automatically within a week or two and how rapidly union occurs

In children under five the gallows method of Bryant gives excellent results and has obvious advantages for nursing purposes over any kind of splint A strapping extension is applied to both legs from groin to ankle and the cords from these extensions are tied to a bar fixed transversely above the frame of the cot at such a height that the buttocks are just lifted clear of the mattress After union has occurred (four or six weeks) another month in bed in a light plaster should be followed by the use of a walking calliper for three months

In older children the methods advocated for adults are preferable Skeletal traction, preferably by Kirschner wire is well tolerated Where the fracture is a partial one a fissured fracture without displacement or one of the greenstick variety a plaster spica is recommended

The Lower End

Fractures of the lower end of the femur are due to direct violence. The line of fracture is either transverse just above the condyles or T-shaped, a vertical fracture running from the transverse one into the intercondylar notch (Fig 507) The upper fragment is usually displaced forwards and engaged in the fibres of the quadriceps The lower fragment is tilted backwards by the gastrocnemius In T-shaped fractures the shaft may be driven between the condyles separating them widely

The region of the fracture is swollen and the knee joint distended with blood or synovial fluid. Abnormal mobility and crepitus become apparent when the limb is handled. Shortening of from ½ to 1½ in. can be made out and in T-shaped fractures the condylar width is usually

increased The lower end of the shaft can be felt above the patella, and the tilted lower fragment may be palpable in the popliteal space but swelling usually prevents their recognition The popliteal artery may be compressed or torn by the lower fragment so that the leg and foot are cold and the tibial pulses absent If the artery is torn a swelling appears rapidly in the popliteal space and gangrene of the leg usually follows in a few hours.

Reduction of transverse or T-shaped supracondylar fractures should be carried out at the earliest moment in order to relieve possible pressure on the popliteal vessels Direct control of the lower fragment is obtained by skeletal traction This is applied from a wire through the tibial tubercle The knee is flexed to 45 degrees and a Braun's splint is used Twenty to 30 lbs extension is used initially but must be reduced to 10 or 15 lbs after reduction has been effected If there is still separation of the condyles after general alignment is restored they are forced together by manual pressure or a screw clamp the jaws of which are padded with felt These fractures usually unite in from eight to twelve weeks and after union is radiographically complete active movements of the knee are started A caliper is worn for a further three months

T-shaped fractures which cannot be brought into satisfactory position by manipulation must be replaced by open operation through a lateral incision.

Fractures of one condyle may be caused by direct violence or by strains of abduction or adduction applied to the leg When there is no separation the limb is fixed in a plaster case with the leg forced towards the opposite side from the injured condyle the case is retained for eight weeks but can be bivalved to allow gentle knee movements within three to four weeks and thereafter a walking calliper worn for three months If there is separation the condyle should be replaced by operation if the displacement cannot be reduced by extension and manipulation

Separation of the Lower Femoral Epiphysis is usually due to forced hyperextension of the knee in patients up to the age of 20 years The epiphysis is displaced forwards the patella forming a prominence in front while the end of the shaft projects into the popliteal space Displacement may however occur in any direction, depending on the nature of the violence *e.g.*, in forcible correction of knock knee when the femur has been insufficiently divided with the osteotome, the epiphysis may be displaced outwards If completely separated it is rotated backwards by the gastrocnemius Replacement should be attempted by manipulation under anaesthesia or by the method recommended for supracondylar fracture operative reposition is seldom necessary

THE PATELLA

Fractures of the patella are of two distinct types those caused by a sudden muscular contraction and those due to direct violence

Fractures due to Muscular Contraction are usually the result of a stumble the full power of the quadriceps being suddenly exerted on

the patella while the knee is flexed The quadriceps tendon or patellar tendon may in some instances be torn but in the great majority the patella itself suffers being snapped across the convexity of the lower end of the femur The line of fracture is single and transverse generally about the middle of the bone but sometimes nearer the upper or more commonly the lower end (Fig 509) The quadriceps tendon is ruptured laterally on either side of the patella The separation may be negligible only a linear crack marking the fracture but in a typical case the muscular pull continuing after the actual fracture pulls the fragments apart a gap of from ½ to 2 or 3 in separates the two parts the torn fringes of the quadriceps aponeurosis hang over the broken edges and the lateral parts of the capsule are torn The joint cavity becomes distended with blood and synovial fluid



Fig. 509
Fracture of the patella.

The patient is unable to walk or extend the leg The knee is swollen and the gap between the fragments may be felt through the skin

In those cases where there is no separation of fragments or where the patient is too old or too ill to stand operation even under local anæsthesia, an attempt should be made to approximate the fragments with strapping the band above the patella being of horseshoe shape The knee is immobilised in full extension in plaster or on a back splint, and movements are started after four weeks including walking but the splint or plaster should not be removed for six weeks

In the average case operative treatment offers the best prospect of reasonable function since only by this means can separated fragments be approximated, aponeurotic fibres cleared from between them, the capsule repaired and blood removed from the joint The accurate reconstitution of the quadriceps tendon of which the patella is only a part is the aim of the operation The front of the joint is exposed by a horseshoe incision convexity downwards the fragments separated and blood and clot removed from the joint The broken surfaces of the patella are cleared and aponeurotic fibres clipped away from the edges The two parts are then fixed together in accurate apposition so that no ridge is left on the articular aspect by strong catgut sutures through the aponeurosis The quadriceps tendon on either side is carefully sutured with mattress stitches A light plaster case is applied and after ten days walking is allowed. The quadriceps is exercised from the beginning The plaster is retained for two months

Fractures due to Direct Violence are the result of blows or falls on the patella The bone is fissured in an irregular manner but unless the patient has attempted to walk after the injury there is usually little separation and the capsule is not torn The knee joint is distended with fluid but contains little blood

Operation in such cases is often unnecessary The treatment is that for fractures due to muscular violence without separation If the fragments are separated they must be carefully dissected out The quadriceps tendon is then reconstituted with strong catgut mattress sutures By overlapping portions of the tendon the final result is such that the absence of the patella is not noticed externally A firm wool pressure bandage is applied and no splint is necessary The patient can start to walk and exercise the knee after ten days This procedure has given surprisingly good functional results and it can also be used in simple fractures of the patella In cases where one of the two fragments is small excision of this fragment followed by reconstitution of the quadriceps tendon is all that is necessary Compound fractures call for excision of the patella

INJURIES OF THE KNEE JOINT

Contusions—Owing to the size of the knee joint bruises involving articular cartilage or synovial membrane which may lead to considerable effusion of fluid are not necessarily accompanied by damage to the capsule In the absence of such damage rest is unwise The joint should be strapped or firmly bound with a crêpe bandage to promote absorption of fluid and active use of the limb encouraged from the start Massage and quadriceps exercises will hasten recovery

Sprains are usually the result of indirect violence movements of rotation or of abduction or adduction beyond the normal range of the joint Fibres of the capsule are torn to varying degrees or separated with a flake of bone at their point of attachment and the synovial membrane is inevitably injured at the same time Sprains are characterised by effusion into the joint pain on movements which stretch the torn ligament and tenderness at the point of injury

Forcible abduction of the leg is the form of indirect violence to which the knee is most often subjected and injury to the internal lateral ligament, therefore the most common form of sprain Abduction may be due to falls or slips or to blows on the outer side of the knee while it is bearing weight There is a sudden severe pain on the inner side of the joint and the patient while able to put his foot to the ground can only walk with pain and difficulty Swelling appears within a few minutes and increases slowly The knee cannot be fully extended but this limitation only involves the last 20 degrees or so of extension and the movement is arrested not by a sudden block but by pain and muscle spasm On examination swelling of the joint is apparent and bruising may be seen on its inner side A point of tenderness will be found over the internal lateral ligament most commonly at its femoral attachment this accurate localisation of the tenderness is an important point in the distinction of a sprain from

a torn internal cartilage where the tender point is half way between the patella and lateral ligament and from a nipped synovial fringe where it is close to the patellar tendon It must however be borne in mind that the internal cartilage is often damaged at the same time as the ligament A gap may be felt in the course of the ligament on abducting the knee pain is increased and laxity of the joint may be demonstrated

The *treatment* of a torn internal lateral ligament is necessarily a compromise between the need for securing sound repair in the ligament and the desire to assist absorption of fluid and maintain the tone of the muscles The measures to be adopted will depend upon the severity of the ligamentous damage since unsound repair will leave a permanently weak knee If the ligament appears to be torn across the limb is fixed in a plaster case from the groin to the ankle with the knee flexed 30 degrees and adducted as much as possible Quadriceps exercises are ordered from the start, and walking is allowed after a week After eight weeks the plaster is removed but a shoe raised ½ in on the inner side of the heel is worn for three months and quadriceps exercises and massage are continued till full functional control of the joint has been regained. The provision of a knee cage should be confined to those cases where a marked lateral rock still exists after prolonged quadriceps rehabilitation In some cases where the periosteal attachment to the femoral condyle has been separated ossification occurs and this has been called Pellegrini-Stieda s disease —traumatic ossification following an internal lateral ligament injury In less severe injuries the joint may be strapped over a small felt pad at the site of injury and walking on a wedged shoe commenced after a week

Dislocation of the Knee.—This injury can only occur when both lateral and both cruciate ligaments have been torn and it is therefore due to gross violence The displacement of the tibia on the femur may be lateral anterior or posterior the direction depending on that of the violence Lateral dislocations are more common while anterior and posterior ones are more serious owing to pressure on the popliteal vessels There are great pain considerable swelling and inability to walk The diagnosis is usually obvious but it is difficult to exclude a concomitant fracture

The reduction of a dislocation of the knee is extremely easy since the ligaments are torn and it should be performed at once The limb should be fixed in a position 5 degrees short of full extension in a close-fitting plaster case extending up to the groin and including the foot Quadriceps exercises may be started at once and walking may be allowed after the fourth week, but the case should be retained for six months Considerable limitation of movement only part of which may be regained, is to be expected after such prolonged fixation, but any shorter period is insufficient to allow strong repair of the torn ligaments A flail knee cannot be efficiently controlled by a cage or satisfactorily repaired by any known operation and is a far greater disability than a stiff and stable one

Dislocation of the Patella is a rare injury and seldom occurs in a normal joint there usually being some knock knee deformity or

laxity of ligaments due to previous injury or disease Dislocation may be caused by direct violence or in the case of faulty alignment by the sudden pull of the quadriceps while the knee is flexed. The only common displacement is outwards Inward displacement and rotary displacement the patella being turned through a right angle with one edge engaged in the trochlear surface are described but seldom encountered Dislocation is accompanied by considerable pain and the knee is fixed in the flexed position. The patella can be seen and felt in its abnormal situation, and after straightening the knee can usually be pushed into place without difficulty

HABITUAL DISLOCATION of the patella is seen in women The first dislocation occurs in knock kneed girls at about the age of puberty and is due to injury or some sudden strain Thereafter displacement recurs with lessening provocation and increasing frequency and may happen almost daily Dislocation may be prevented by a knee cage which limits flexion and carries a pad supporting the patella on its outer side but in most cases operation is preferable Any pronounced degree of knock knee should be corrected as a preliminary measure. The most successful method of curing recurrent dislocation is by transplanting the tubercle of the tibia and the patellar tendon to the inner side of the tibial crest Laxity of the inner side of the capsule may be taken up at the same time The patella may also be excised and the quadriceps strongly reconstituted.

INTERNAL DERANGEMENTS OF THE KNEE

The term "internal derangements embraces a group of injuries to the knee usually due to twisting or abduction strains in which damage to internal structures predominates Some lesion of the capsule or more especially of the internal lateral ligament almost necessarily accompanies the intra-articular one

Nipping of a Synovial Fringe.—In sudden unguarded movements of the knee joint, folds of synovial membrane may be drawn between the articular surfaces and nipped when these latter come into apposition Synovial thickening or laxity of ligaments from previous injury or disease predispose to the accident A typical example of such an injury is nipping of the ligamentum alarium internum the free fold which passes from the infrapatellar pad of fat to the interior of the joint Sudden abduction of the leg separates the joint surfaces on the inner side and a sudden return to the normal position crushes the fold between the internal femoral condyle and the internal meniscus There is momentary pain on the inner side of the joint often severe enough to inhibit the muscles maintaining extension and let the patient down." Walking is however possible with the knee slightly bent

Upon examination after a recent injury the joint is found distended with fluid and some swelling on the inner side of the patellar tendon will also be noted Full extension is impossible but the limitation is indefinite within about 10 or 15 degrees of the full range this being in sharp contrast to the complete block to extension at 30 or 40 degrees

cartilage is pulled backwards by its attachment to the internal lateral ligament and the anterior half is straightened across the front of the joint It is doubtful if either displacement can reach the stage at which there is risk of injury if the attachments of the cartilage are normal some of these attachments are either torn at the time or have been stretched by previous injury disease knock knee deformity or habitual posture In most cases the causative injury is a combined movement of abduction and internal rotation with the knee slightly flexed as in a drive at golf or a sudden turning movement in tennis or cricket the knee is straightened in the position of strain, and the cartilage is sheared between the articular surfaces The cartilage injury may be a longitudinal split in which the central portion is displaced towards the intercondylar space (bucket handle type) there may be separation of the peripheral attachment or there may be tears of the central free margin or of the anterior or posterior horn The more the knee is flexed at the time of the injury the more posterior is the lesion in the cartilage

The patient is usually adult During a sudden turning movement he feels a sharp pain on the inner side of the knee which lets him down. On attempting to move he finds he cannot straighten the leg the last 30 degrees (locking) and is usually unable to walk The joint becomes rapidly distended with synovial fluid. After a variable period and as the result either of manipulation or some sudden movement, the leg can again be extended fully the freeing of the joint is as sudden as the locking and is accompanied by the sensation of something clicking or slipping into place on its inner side The effusion subsides and the knee recovers

If a case is first seen with the knee locked the cartilage must be replaced by manipulation The inner side of the joint is first opened up to free the cartilage by flexing the knee and abducting the tibia on the femur in this position the tibia is internally rotated to its fullest extent and the knee is then straightened. It is more usual for the case to be seen after spontaneous reduction of the locking and the diagnosis depends in the main upon the history Locking however is not an essential clinical feature as several types of cartilage injury do not give rise to locking but do occasion attacks of giving way and insecurity of the joint The points to which importance must be attached are that the movement causing the accident was one of abduction or internal rotation and of some violence that locking was immediate and complete in a position of at least 30 degrees flexion that subsequent freeing of the joint occurred suddenly that synovial effusion followed the accident and that a tender point is found about midway between the patellar tendon and the internal lateral ligament together with a slight localised fullness at this point.

The menisci are repaired after injury by connective tissue If the attack is the first one and locking has been reduced early and completely it may be assumed that the torn portion has returned to its normal position. Tears of the avascular cartilage may not heal at all or heal only very imperfectly while peripheral attachment tears unite if the joint is immobilised for four to six weeks Treatment consists

in firm bandaging and quadriceps exercises to remove the synovial fluid and restore the tone of the muscles a shoe raised on the inner side to facilitate repair of the coincident injury to the internal lateral ligament and prevent abduction strains and the avoidance of all games involving sudden turning movements for three months If these precautions are not carried out or if the injury is repeated before healing is complete repair does not take place or does so with some deformity of the cartilage Repeated attacks are to be expected. These are brought on by strains similar to those causing the original injury but occur more easily sometimes appearing with any unguarded movement In each there is typical locking but the pain and synovial reaction become progressively less and reduction easier While the disability is therefore less severe it must be remembered that recurring derangements of this nature lead to traumatic arthritis in the joint After a second attack the damaged cartilage should be excised.

Injuries of the External Semilunar Cartilage are less common They are caused by strains of adduction combined in most cases with rotation, and present a similar history and physical signs to those outlined above The pain is usually localised less accurately and may be referred to the back of the joint The treatment is similar to that for lesions of the internal cartilage

Rupture of Cruciate Ligaments.—The cruciate ligaments either both or the anterior alone may be torn (usually incompletely) by violent twisting movements in which the internal lateral ligament is almost necessarily damaged at the same time The immediate symptoms are those of a severe sprain pain in the joint effusion and inability to walk later when the pain becomes less and the fluid subsides, instability of the joint will be noticed. On examination the characteristic feature is an increase in the anteroposterior movements of the femur on the tibia. The knee should be flexed to a right angle to relax the lateral ligaments and in this position the tibia is pulled forwards and pushed backwards an increase of forward movement indicates injury to the anterior and of backward movement to the posterior ligament Some anteroposterior movement is possible in the normal knee and the sound side should be examined for comparison An X ray may show that a flake of bone in front of the tibial spine has been torn from the tibia with the attachment of the anterior ligament

When rupture of the anterior cruciate ligament is recognised at an early stage the limb should be immobilised in a plaster case for three months with the knee flexed 30 degrees Injury of the posterior cruciate ligament is immobilised in full extension with the head of the tibia pulled well forwards Injury of both cruciate ligaments demands similar immobilisation [illegible] a position of semi flexion. In an old case with excessive [illegible] useful function can usually be obtained [illegible] cating tl [illegible] providing a knee cage extending t[illegible] n the he[illegible] ctively prevents anteroposterior m[illegible] e a[illegible] flexi[illegible] extension. Operations t[illegible] on of [illegible] lig[illegible] ve been devised but [illegible] give m[illegible] p[illegible] nent

In some cases of rupture of the crucial ligaments the disability is surprisingly slight

Fracture of the Tibial Spine *per se* does not occur but it may be avulsed together with tibial attachment of the anterior cruciate ligament It may be possible to replace the separated fragment by *manipulation* but if this is unsuccessful operative reduction is advisable After satisfactory reduction the knee is immobilised in extension until union is sound quadriceps *exercise being practised* assiduously

Loose Bodies in the Knee Joint.—The discussion of loose bodies in the knee is included in this section because some of these are traumatic and others partly traumatic in origin and because the symptoms they cause closely resemble those of a torn cartilage One type of loose body is due to osteochondritis dessecans *usually involving* the intercondylar aspect of the internal condyle of the femur As a result of aseptic necrosis a portion of cartilage and underlying bone is separated and becomes loose in the joint Other loose bodies are thickened synovial fringes or osteophytes the result of osteo-arthritis which have become detached by violence Others again are due to a metaplasia of the synovial membrane into cartilage plaques of flattened oval or rounded shape being formed in the lining surface of the joint which at first sessile later are attached by a thin membrane and eventually become free Bodies of the last type may be very numerous The characteristic symptoms of a loose body are repeated attacks of locking These attacks differ from those found with a torn cartilage in that they recur more often, the position of locking and of pain varies the reaction is less and unlocking usually follows within a few moments The patient is generally aware of the body and can locate its position An X-ray will confirm the diagnosis and demonstrate the number of loose bodies *present* The *treatment* is removal by operation When the body is single and movable it should be manipulated to the inner side of the suprapatellar pouch and removed through a small incision If multiple bodies are present or one is in an inaccessible position, wide exposure of the joint is necessary *this may be obtained by a long curved incision* to the inner side of the patella.

FRACTURES OF THE TIBIA

Fractures of the Head of the Tibia may be due to direct violence to falls *on the feet* or to lateral strains Fractures due to direct violence are comminuted and often compound but there is no gross separation. Those due to falls on the feet are *usually T-shaped the shaft* being driven between the tuberosities Forced abduction or adduction tends to produce a *fracture of the* whole or part of one tuberosity which is displaced downwards by the corresponding femoral condyle The external tuberosity *is* much more frequently fractured and it is essential to understand that *this is only one* item in the injury an acute valgus strain with tearing of the internal lateral and possibly the cruciate *ligaments. All the signs* of fracture are usually present and the knee is distended with blood and synovial fluid. The diagnosis is

a plaster case applied and worn for eight weeks If the fracture line is at or above the middle of the shaft the plaster must extend up to the thigh the knee being slightly flexed *A walking iron described* under fractures of the tibia and fibula, may be added after the third week or earlier if the injury is to the lower half of the bone

FRACTURES OF THE FIBULA

The shaft and upper end of the fibula may be broken by blows on the outer side of the leg The line of fracture is usually transverse and the separation negligible Twisting forces applied to the foot may also break the fibula in a spiral manner at its weakest point the upper third of the shaft

The disability caused by a fracture of the shaft of the fibula is not great and walking though painful is possible The diagnosis is usually made by the discovery of bruising and persistent pain at one point in the line of the bone and by tenderness at this point when the fibula is sprung by pressure at some distant point In fractures near the neck the external popliteal nerve may be injured either at the time by the agent causing the fracture or later by pressure of callus There are no forces tending to cause displacement and with rest strapping and later massage complete recovery of function can be expected.



Fig 510

A, anteroposterior and B, lateral views of fractures of the tibia and fibula due to indirect violence.

FRACTURES OF THE TIBIA AND FIBULA

Fractures of the tibia and fibula together due both to direct and indirect violence are among the commonest encountered in practice

In fractures due to *direct violence* both bones are broken at the same level. When the violence is moderate the line of fracture is transverse or comminuted to some extent The displacement is variable and depends on the nature of the injury but is not usually great with comminution however there is a tendency for small portions of tibia to be detached and rotated between the main fragments *Many of these fractures are compound.* In those due to severe violence, such as motor accidents the soft tissues are often severely lacerated and soiled and the bones grossly comminuted

Fractures due to *indirect violence* are usually the result of falls on the feet or twisting strains while the leg is bearing full weight The level of fracture is almost constant each bone breaking at its weakest point the tibia at the junction of the middle and lower thirds the fibula in its upper half The line of fracture in each is oblique or spiral, reaching its lowest level in front and to the inner side (Fig 510 A and B) Since the force continues to act after fracture there is usually displacement the leg being shortened and the upper fragment overriding the lower on its inner side Indirect fractures are often compound the sharp part of the upper tibial fragment making a punctured hole in the skin

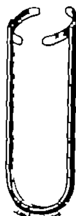


Fig 511

A Böhler iron, which is incorporated in plaster of Paris to permit walking (Allen & Hanburys)

The *diagnosis* of fracture of the tibia and fibula is usually obvious, all the classical signs of fracture being present Swelling especially in simple fractures may reach an extreme degree even endangering the vascular supply of the limb

Treatment will depend upon the nature of the fracture and the displacement Fractures without displacement (usually transverse) which can be brought into good position by manipulation and are reasonably secure after reduction should be immobilised in a plaster case applied directly to the skin. If there is much swelling the limb may be kept on a back splint for a few days before the plaster is applied Except in a few cases of fracture in the lower third where the danger of redisplacement is ruled out by the nature of the fracture the plaster must extend to above the middle of the thigh with the knee in 5 degrees of flexion. The foot is held at a right angle and the plaster must support the plantar aspect of the toes Within a day or two a bar of iron, bent in the form of a U is attached to the case in the line of the malleoli with additional plaster bandages its lowest part projecting 1 in. or more below the sole of the case (Fig 511) Alternatives to the walking iron are pieces of wood or old motor tyre suitably shaped and incorporated in the plaster These are more stable than the iron The patient is allowed to walk on this till the eighth to tenth week, when the plaster is removed If union is then satisfactory walking is allowed and exercises ordered to increase ankle movements if there is weak union or none a fresh walking plaster is applied

In unstable fractures such as oblique and spiral traction is advisable for at least three weeks after reduction The pin through the os calcis is incorporated in a below-the-knee plaster and the limb is supported on a Braun's splint Ten to 15 lbs weight are used the foot of the bed being raised on blocks (Fig 512) Later when swelling has subsided and X-ray shows that the reduction is satisfactory a skin tight plaster from the toes to above mid thigh is applied the pin being left in until the plaster has ly set

Where there is considerable dis reposition can be obtained

as a rule by screw traction on a Böhler frame (Fig 513) or Hawley table The knee is flexed and in Böhler's method the traction is applied

FIG. 512
Fracture of shaft of tibia
In unstable fractures and all fractures with severe swelling the transfixion pin is incorporated in the plaster and continuous traction is maintained for five or six weeks. (*Watson-Jones.*)

by a calcaneal clamp *When the position is good, two pins are inserted* one through the upper and one through the lower end of the tibia and



FIG. 513
Böhler's screw-traction frame. (Allen & Hanburys)

these are incorporated in a plaster case the calcaneal clamp being removed when the plaster is dry In four or five days Böhler applies a walking iron to the same case over the lower pin and the patient

gets up Alternatively continuous traction may be used a pin being driven through the os calcis This has the advantage of allowing œdema to subside before the application of a plaster which must be split longitudinally if put on in the presence of much swelling The screw traction method is likely to give better reposition and Böhler advocates the inclusion of transfixion pins in any plaster that is used for walking in the first two or three weeks.

If satisfactory position cannot be obtained by these methods usually because some muscle or small fragment of bone is interposed between the main ones operation is in most cases advisable The fragments are replaced and if they are then secure the limb is immobilised in plaster which after three weeks is replaced by a walking plaster case If the fracture shows a tendency to redisplacement the fragments should be fixed with a bone plate

INJURIES INVOLVING THE REGION OF THE ANKLE JOINT

Fractures of the ankle joint are almost without exception, the result of indirect violence applied to the foot Such violence may take the form of strains of abduction or adduction, or of external or internal rotation since a much greater part of the foot projects in front of the ankle than behind it abduction is usually accompanied by external rotation, and adduction by internal rotation In such strains the astragalus remains with the foot and is rarely injured but forms the instrument by which the malleoli are fractured Fractures due to pure lateral or rotary strains are described but in the great majority of instances the two are combined. Abduction and external rotation account for most of these fractures violence in the opposite direction is usually less severe and causes a sprain rather than a fracture

Abduction Fractures—POTT'S FRACTURE —These fractures are produced by indirect violence the force being a mixture of abduction eversion and external rotation of the astragalus and foot

This force falls first on the inner side of the ankle joint and results in either a torn internal lateral ligament or a fracture of the tip of the internal malleolus This allows the astragalus to be forced out against the fibular malleolus In the majority of cases the strong inferior tibio-fibular ligaments remain intact and act as a *fulcrum* around which the fibula is bent. If the force driving the external malleolus outwards is strong enough the shaft of the fibula gives way at a distance above the tibio-fibular ligaments approximately equal to the distance from those ligaments to the tip of the malleolus This fracture is typically oblique running from behind downwards and forwards If the abduction element predominates over the eversion the fracture line tends to approximate to the level of the tibio-fibular ligaments and is more transverse Either of these types constitutes a Pott's fracture

Secondary forces conspire to produce the more severe *forms* of ankle fractures Anterior or posterior shift accompanying the main twisting force may lead to the so-called marginal fractures of the lower cup-shaped articular surface of the tibia and these together

with disruption of the malleoli destroy the mortice joint of the ankle allowing the astragalus and foot to be pulled backwards by the attachment of the tendo achillis to the os calcis In the worst type a *combined* upward force leads ultimately to rupture of the inferior tibio fibular ligaments and the displacement upwards between the tibia and fibula of the astragalus This is a Dupuytren s fracture-dislocation (Fig 514) of the ankle Many of the more severe types of abduction fracture are comminuted

The *clinical picture* is usually obvious A typical history of injury the usual signs of fracture marked and rapid swelling and discoloration and a characteristic deformity—the foot being abducted and everted plantar flexed and drawn backwards—make diagnosis easy But an X ray in two planes should always be taken both before and after reduction



Fig 514

A fracture-dislocation of the ankle joint, i.e., a Dupuytren fracture.

By far the majority of cases can be *treated* by manipulation reduction and fixation in plaster If the case is seen so long after the fracture that swelling is excessive temporary fixation on a back splint with right-angled foot piece together with elevation of the whole leg combined with frequent massage should be carried out until such time as it is deemed possible to apply a skin plaster

The essence of reduction is good general anaesthesia and a well relaxed tendo achillis This is best achieved by having the patient prone on the table with the thigh hanging vertically over the end of the table and the leg flexed at right angles at the knee lying horizontally on a stool, the foot pointing downwards over the end of the stool This position will result, in most cases in the automatic reduction of the backward displacement if not only slight pressure on the heel completes it The astragalus is easily pushed inwards so as to come into closest apposition with the outer aspect of the internal malleolus With the patient lying in this position the fracture does not tend to redisplace and a posterior plaster slab is applied from just below the knee round the heel to just beyond the toes The plaster case is then completed from the tuberosities of the tibia to the toes (Fig 515) This method ensures the easy reduction of both the backward and outward displacements and can be carried out single-handed The foot should be at right angles, but can be dorsiflexed further if necessary An immediate X ray should show that the upper surface of the astragalus is horizontal that the inner aspect of the astragalus is well home into the outer aspect of the internal malleolus and in the lateral view

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that the astragalus is articulating accurately with the forward main portion of the tibia A Böhler's walking iron or walking heel is applied and the patient allowed to get about If the swelling at the ankle joint has been at all marked the patient should be seen in a day or two after the reduction as the plaster may have become so loose as to require reapplication This ambulant treatment is continued for from six to ten weeks according to the severity of the fracture and the success of reduction When the plaster is removed the foot ankle and leg should be firmly strapped with elastoplast for a further two to three weeks and a wedge on the inner side of the heel of the shoe may help



A



B

Fig 515

After manipulative reduction an assistant holds the foot in dorsiflexion while plaster is rapidly applied (Fig. 515 A). During this stage or while the plaster is setting, backward dislocation may recur The foot must be pulled strongly forwards and inwards by the surgeon's hands, dorsiflexed with his knee and held while the plaster sets (Fig 515, B). (*Watson-Jones*)

considerably A well treated case of abduction fracture should be walking normally within three months from the date of injury

In those few cases where manipulative reduction is unsatisfactory os calcis skeletal traction with the knee flexed, or open operation and mechanical fixation of the fragments may be necessary In cases seen late when the deformity is uncorrected or the astragalus remains tilted or has not been forced sufficiently inwards or forwards considerable pain and disability are going to result Further attempts at reduction can be made up to six to eight weeks after injury If these are unsuccessful it will probably be necessary to arthrodese the ankle joint in 10 degrees of plantar flexion

Adduction Fracture of the Ankle (Wagstaffe's Fracture)—*First Degree.*—The external malleolus is fractured transversely at the

joint level and the internal malleolus obliquely at its base the line of fracture passing upwards and inwards There is no displacement

Second Degree—The foot and astragalus are displaced inwards the fibular fracture is the same as in that of the first degree but the tibial fracture usually starts in the lower articular facet and passes upwards and inwards a triangular piece including the malleolus and part of the lower end being detached and displaced upwards

Adduction fractures should be reduced under general or local anæsthesia by methods similar to those employed for Pott s fracture The plaster case should be applied with the foot dorsiflexed to 90 degrees and midway between inversion and eversion

Separation of the Lower Tibial Epiphysis.—Separation of this epiphysis is caused in children and adolescents by violence similar to that which produces abduction or adduction fractures in adults Similar displacements are found but since the injury is at the epiphyseal line the displaced fragment of the tibia includes the articular surface as well as the malleolus The fibular epiphysis may be separated or the bone fractured above the epiphyseal line The treatment is that of ankle fractures in adults Premature synostosis of the lower tibial epiphysis may result from this injury and give rise to increasing varus deformity at the ankle because of the continued growth at the lower fibular epiphysial line This must be excised to stop its growth and correct the deformity

Fracture of the Astragalus.—The astragalus is rarely injured but it may be broken by falls from a height in the standing position. If the foot is at right angles at the time of impact the body of the bone is crushed, the fracture being comminuted, and the bone flattened from above downwards and broadened If the foot is dorsiflexed a transverse fracture of the neck is more common The head is displaced upwards and the calcaneo-cuboid joint is usually dislocated at the same time

Fractures of the astragalus are accompanied by great pain and disability There is much swelling and bruising round the ankle, but the malleoli and os calcis can be felt in their normal relationship The diagnosis is therefore made by exclusion and must be confirmed by X rays

Fractures without obvious displacement should be immobilised in an unpadded plaster case with the foot at right angles A walking iron can be added in a day or two but weight bearing should not be allowed for at least two months

Fractures of the body with displacement are restored to approximately correct shape by traction and manipulation A Kirschner wire is passed through the os calcis and screw traction applied on a Böhler s frame When shortening has been overcome the sides of the bone are compressed by a screw clamp padded with felt until its diameter is that of the uninjured astragalus An unpadded plaster case is applied and the limb transferred to a Thomas' splint when a weight of 10 lbs is attached to the Kirschner wire After four weeks the wire is withdrawn and a fresh walking plaster applied. Weight bearing is allowed after twelve weeks

Fractures of the neck, which are usually associated with dislocation of the subastragaloid joint are replaced under anæsthesia by traction and forced plantar flexion of the foot A plaster splint is applied in the plantar-flexed position After eight weeks a fresh walking plaster is made with the foot at right angles This plaster is discarded after a month but an arch support should be worn for three months

Sprains of the Ankle Joint.—Sprained ankle is a very common accident It implies rupture of part of the internal or external ligaments of the ankle joint by an outward or inward twist of the foot The only common sprain is that caused by the foot being turned inwards a force of adduction and internal rotation, which throws a maximum strain upon the anterior fasciculus of the external lateral ligament Sudden pain is felt just in front of the external malleolus with a sensation of something tearing In severe sprains a snap may be heard The ankle swells rapidly and bruising appears on the outer side Upon examination it is found that the malleolar measurements are normal there is no crepitus the bruising is in front of rather than over the external malleolus and an area of tenderness is discovered in the hollow immediately in front of this point X ray examination is always necessary to exclude fracture of the malleoli or of the base of the fifth metatarsal.

The foot should be bandaged firmly and rested completely for forty-eight hours to prevent further effusion A firm strapping of elastoplast is then applied and the patient allowed to walk in a shoe, the sole of which has been raised ¼ in. on the outer side to prevent inversion After ten days the strapping may be left off and massage ordered but the raised shoe should be worn, in all except slight cases for six weeks If after three months the ankle is still painful and swells after exercise and there is limitation of inversion and plantar flexion it should be manipulated under an anæsthetic special attention being directed to regaining the normal anteroposterior movement between the astragalus and tibia

Dislocation of the Ankle.—This is an uncommon injury due to severe violence only forward and backward dislocations are possible without fracture and of these the backward is the less rare The deformity is usually obvious the foot appears short and the heel is more prominent than its fellow A third degree abduction fracture is excluded by the absence of crepitus and the normal position of the two malleoli

Reduction is easily accomplished but an anæsthetic is usually advisable A walking plaster should be applied with the foot at right angles and retained for eight weeks If swelling persists after removal of the plaster the ankle should be strapped with elastoplast.

FRACTURES OF THE TARSUS, METATARSUS AND PHALANGES

Fractures of the Os Calcis.—Two types of fracture are seen in the os calcis, compression fractures due to falls on the feet in the standing position and fractures of the tuberosity The former are much the commoner

COMPRESSION FRACTURES are caused by falls from a height on to the feet or by jumping from a moving vehicle the bone being crushed against the ground by the weight of the body transmitted through the astragalus The resulting fracture is comminuted in an irregular manner The os calcis as a whole is flattened and broadened the front portion compressed from above downwards and expanded in the transverse plane the back portion drawn up The patient complains of great pain and is unable to walk The heel is bruised and swollen the hollows round the tendo achillis being obliterated On examination crepitus

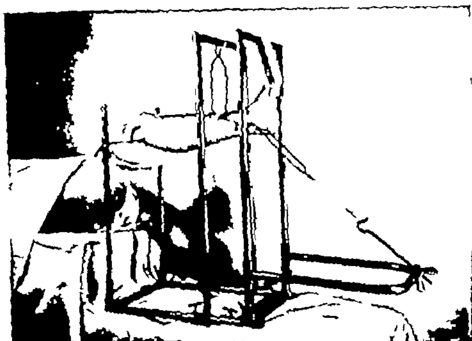


FIG. 516

Fracture of the os calcis.

A wire through the shaft of the tibia steadies the leg A second wire through the os calcis enables traction to be made backwards and downwards in the long axis of the tuberosity of the os calcis. In this position a plaster is applied. (*Watson-Jones*)

may be found lateral movements of the heel are resented but gentle movements of the ankle joint can be performed

Fractures of the os calcis with little or no displacement should be treated in a walking plaster for six weeks Where there is deformity rest in bed for a similar period probably gives better ultimate results than attempts at reduction as previously popularised by Böhler If formal reduction is attempted a wire is inserted through the tibia in its lower fourth and a second wire in front of the point of insertion of the tendo achillis into the os calcis The leg is suspended by the first wire in a Böhler frame and traction is made on the second at 45 degrees to the line of the leg until flattening and upward displacement have been overcome (Fig 516) The bone is then compressed laterally by a screw clamp of special design until its width is similar to that of the opposite

side An unpadded plaster case is now applied with the foot at right angles and split along the dorsum The limb is transferred to a Braun's splint and a weight of 10 lbs attached to the wire through the os calcis pulling downwards and backwards After one month the wire is removed and a walking plaster applied. Weight bearing should not be allowed for a further six weeks These fractures even when efficiently treated may leave a permanent disability owing to traumatic osteo-arthritis of the subastragaloid joint Cases of very persistent pain can often be relieved by arthrodesis of this joint

Fractures of the Tuberosity are due to direct violence rather than muscular pull. A portion of the tuberosity varying from a flake to a large triangular fragment is displaced upwards In young patients the epiphysis may be separated

When there is no great displacement, a plaster case may be applied in the position of slight plantar flexion and retained for six weeks Walking may then be allowed in a shoe with a raised heel. Even if there is marked displacement it is not difficult to reduce the fragment by manipulation.

The remaining bones of the foot are usually injured by direct violence such as crushing or the impact of heavy weights The fracture may involve the cuboid scaphoid cuneiforms or metatarsals and often implicates more than one bone Pain, bruising and disability are always present but deformity and crepitus are seen only in the more severe fractures While the diagnosis is usually clear the bones affected and the degree of displacement can be established only by X rays.

The foot should be moulded back to correct shape under anæsthesia, care being taken to restore the longitudinal and transverse arches and enclosed in an unpadded walking plaster Weight-bearing may be allowed after eight weeks in a shoe fitted with an arch support.

Fractures of Single Metatarsals.—The shafts of the 2nd 3rd and 4th metatarsals and the base of the 5th may be broken by minor degrees of violence such as walking over rough ground in heavy boots (march fracture or *pied forcé*) Several of the metatarsals may be involved. The fracture is transverse or oblique and the separation is negligible Persistent pain and swelling over one metatarsal will suggest the diagnosis of fracture which must be confirmed by X-rays The fracture is sometimes such that it may be missed in X-ray examination, and only the subsequent development of a collar of callus reveals the site of the fracture

If there is no displacement and the fracture involves the 2nd, 3rd or 4th metatarsal shaft, strapping the metatarsals together firmly with elastoplast is sufficient If the 1st or 5th metatarsals are fractured or if there is any displacement in fractures of the other metatarsals a moulded walking plaster to include the calf must be applied for four weeks after which it can be replaced by strapping Extension will be necessary in fractures of the necks of the metatarsals where marked displacement occurs

Fractures of the Phalanges.—Any of the phalanges, but especially the terminal phalanx of the great toe may be broken by the fall of weights or by stumbling against hard objects. In most cases there

is no gross displacement If there is deformity the alignment should be corrected and the toe strapped for three weeks to a padded strip splint of aluminium otherwise the foot should be rested until bruising has disappeared

INJURIES OF THE SPINE

Injuries of the spine may be caused by indirect or direct violence the latter being *responsible* for a small proportion only and these the less serious

Fractures of the Vertebral Bodies.—The vertebral bodies are fractured by forcible flexion of the spine beyond its normal limits

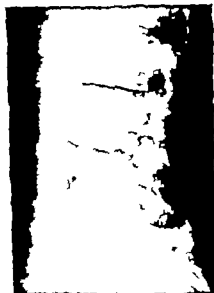


Fig. 517

A compression fracture of a lumbar vertebra without dislocation.



Fig. 518

Kummell's disease.

so that the anterior parts of the bodies are compressed The *thin* shell of compact bone is first broken in front but when it has yielded the body offers little resistance to further compression and becomes split by radiating fissures the direction of which is chiefly transverse If the force continues the bone becomes compressed in the long axis (the deformation being most marked in front) and expanded in the lateral and to a less extent in the anteroposterior planes The neural arches are first held together by interspinous and articular ligaments but with further flexion these rupture and the laminae are torn apart The portion of the spine above the fracture is then displaced forwards on the lower part Fracture of the bodies usually involves one vertebra only but two or three adjacent ones may be broken. The last two dorsal and first lumbar vertebrae are those most commonly injured next in frequency come the upper dorsal vertebrae In the cervical region the bodies are shallow and the intervertebral discs wide and

resilient so that a force of flexion sufficient to injure the column produces separation of the neural arches before fracture of the bodies. Extension injuries of the spine are rare

Compression Fracture without Dislocation is fairly common The injury may be the result of a fall or some industrial accident, and is sometimes seen after violence of quite moderate severity such as sudden stopping of a vehicle or missing a step Often there is no deformity and the fracture may be unsuspected at the time After the accident the patient complains of pain sharply localised to one part of the spine usually the lower dorsal region and holds his back stiffly Pain is increased by jolting and by movements of the trunk. On percussing the spinous processes one is found to be tender and jarring the head produces pain at the same level. In other cases the spinous process of the affected vertebra may form a visible prominence

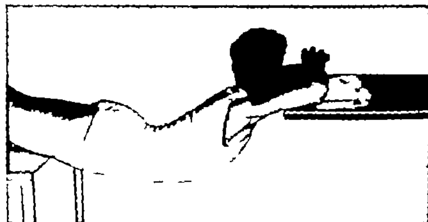


Fig 519

Correct position for postural reduction. The lower table extends to the upper thighs; the upper table is clear of the chest. (Watson-Jones)

Girdle pains are sometimes produced by irritation of the spinal nerves, and rarely there may be symptoms of pressure on the anterior columns of the cord due to a bony fragment projecting into the vertebral canal An X ray should be taken in every case of injury to the spine It is extremely important that even slight fractures should be recognised early and this requires very good films The anteroposterior view will give little help in the diagnosis of a fissured fracture without displacement A good lateral film (Fig 517) or a stereoscopic pair must always be obtained.

If such fractures are unrecognised and untreated, the vertebra even when it is not deformed by the accident will slowly yield to the force of gravity and become compressed in its long axis The final result is a wedge-shaped vertebra a condition which used to be called **Kummell's disease** (Fig 518) before its traumatic origin was recognised. Weakness and inability to carry out strenuous work, persistent pain at the site of fracture and, later osteo-arthritic changes and irritation of the spinal roots by osteophytes are the outcome

Fracture of a vertebral body should be treated by correction and immobilisation at the earliest opportunity The deformity has been produced by forced flexion extension if applied within a week of the accident will restore the length of the vertebra and mould the fragments into approximately normal position The patient is given ¼ gr of morphia and placed prone between two tables with the thighs resting on one and the arms on another—which latter should be 12 in. higher (Fig 519) A vest is slipped over the trunk and the sternum pubis iliac crests and spinous processes lightly padded with adhesive felt. When the spine is fully hyperextended, a close-fitting plaster jacket is applied well moulded round the pelvis and extending in front from the episternal notch to the pubis (Fig 520) When set the plaster is trimmed to free the axillæ and thighs After ten days recumbency the patient is allowed to walk in the jacket which must be retained for four months after which a spinal support should be worn for another three months From the very beginning the patient is made to carry out exercises regularly while in plaster and latterly he can leave off the support for this purpose The exercises should be of the extension type and flexion of the spine should be avoided until late



FIG. 520

Correctly applied plaster extending from the groins and symphysis pubis to the clavicles. The lumbar spine cannot be flexed. (*Watson-Jones.*)



FIG. 521

A fracture-dislocation of the cervical spine

Fracture dislocation of the Spine is caused by violent flexion of the trunk, such as may occur in motor accidents or when a weight falls on the shoulders of a stooping labourer The body of the vertebra is first fractured (Fig 521) and the neural arches are then torn apart by rupture of the ligaments and dislocation or fracture of the articular processes The upper part of the fractured vertebra is displaced forwards on the lower and the cord is compressed between the lamina above and the posterior edge of the lower vertebral body In rare instances the cord escapes injury but some interruption of its function is almost inevitable The patient is usually

profoundly shocked and in great pain Sensation and movement in the lower limbs may be lost The distribution of the paralysis will vary with the level of the fracture this subject is considered in detail under injuries of the spinal cord (Chap XLII) Upon examination bruising will be noticed at the site of injury and the spinous process of the fractured vertebra forms an obvious projection. The sternum may be fractured transversely in its upper part the manubrium overriding the body *Great care should be taken in examining any patient who may have sustained a fracture of the spine in order to avoid increasing the displacement and all such cases should be lifted and transported in the prone position*

Paralysis may be due to compression of the cord only or to destruction of its tissues in the first case recovery may ensue in the second none is possible A destructive lesion is the commoner but since it is impossible to recognise the nature of the neural damage on clinical grounds it should be assumed in every case that the cord is compressed only and the pressure removed by correcting the deformity This should be done at once in order to avert further damage to the spinal cord, but the patient is often too shocked to allow of much manipulation. Perhaps the best method is for the surgeon and assistant to apply traction and counter traction on the head and feet respectively while pillows are wedged in under the deformity to hyperextend the spine This is done on a firm bed on which the patient is left until shock has passed off sufficiently to allow a plaster bed to be made A turning case is constructed as well, so that the position of the patient can be altered and attention paid to the skin of the back. Constant care is necessary to avoid bed-sores infection of the bladder and contractures of the lower limbs

Dislocation of the Spine.—Pure dislocations are seen only in the cervical region

UNILATERAL DISLOCATION is caused by forced movements of lateral flexion of the neck combined with rotation. The lower articular process of one vertebra usually the 3rd or 4th, slips over the upper one of the vertebra below on one side and lies in front of it, the articulation of the opposite side remaining normal. The neck is flexed and rotated to the opposite side to that of the injury Pain is felt at the site of dislocation and all movements of the neck are restricted. On examination an irregularity will be felt in the line of the transverse processes and tenderness found at the level of injury The body of the upper vertebra may be palpated as a projection in the posterior pharyngeal wall The cord is not injured, but pain may be referred along the dorsal root of the cervical nerve emerging below the displaced articulation.

BILATERAL DISLOCATION is due to forced flexion of the neck. The body of the vertebra is usually fractured in addition but this is not invariable Even with fracture of the body the cord in the cervical region not infrequently escapes damage

The neck is bent forwards and held stiffly Very little movement is possible and in sitting or walking the patient thrusts the chin forwards and turns the eyes up A break in the line of the transverse

and spinous processes will be felt and tenderness is found in both situations

Dislocations of the cervical spine should be reduced immediately under general anæsthesia Steady traction is applied to the head which is then pulled backwards in bilateral and rotated towards the injured side in unilateral dislocations Reduction occurs with an audible snap After reduction a well moulded plaster collar should be applied over a padding of felt this should support the jaw in front and the occiput behind and below should take its bearing on the sternum and clavicle The plaster should be retained for four months

INJURIES OF THE ATLAS AND AXIS —The only common injury of the upper cervical vertebræ is forward displacement of the atlas on the axis due to accidents in which the head is wrenched violently forwards The transverse ligament may be ruptured or the odontoid process fractured In the first case the medulla is impaled on the odontoid process and death is instantaneous In the second the medulla is protected by the transverse ligament and there may be no neurological symptoms The head is held stiffly and all its movements are painful The spinous process of the axis is unduly prominent. Many of these injuries however escape recognition for some time and an X ray is necessary to establish the diagnosis The displacement should be reduced by traction under anæsthesia and a plaster collar applied as for other cervical dislocations

FRACTURES OF THE NEURAL ARCHES —Fractures of the spinous processes and laminæ are occasioned by direct violence The former are more commonly injured in the dorsal and the latter in the cervical regions. Pain, loss of movement signs of local injury and occasionally crepitus suggest the diagnosis of fracture which must be confirmed by X rays The cord is occasionally injured by a depressed fracture of a lamina especially in the cervical region When there are signs of cord injury operation for removal of the pressure is imperative In other cases a plaster jacket or collar should be made

The TRANSVERSE PROCESSES are injured in the lumbar region by direct violence the injury can be demonstrated only by X rays Rest in bed for four weeks with the leg flexed over a pillow to relax the psoas is sufficient treatment

FRACTURES OF THE STERNUM

The sternum may be broken by indirect violence accompanying fractures of the spine The fracture is a transverse one at the level of the manubrio-sternal junction and the upper fragment overrides the lower The deformity disappears when that of the spine is corrected

Fractures of the sternum due to direct violence are the result of severe accidents such as motor and aeroplane smashes or falls under the wheels of a vehicle Fractures of the ribs and injury to the intrathoracic viscera commonly accompany the sternal injury Such fractures involve the upper part of the bone and take the form of irregular fissures without gross separation. The patient is usually

shocked and in great pain dyspnœa and disordered action of the heart are also characteristic The pain is increased by movement and local tenderness is found over the site of fracture

The sternum should be immobilised by crossed bands of adhesive plaster passing from the axillary line on one side to the clavicle on the other The patient is nursed in the Fowler position which favours diaphragmatic respiration and minimises the risks of pulmonary complications After three weeks he may be allowed out of bed.

FRACTURES OF THE RIBS

Fractures due to direct violence are caused by accidents similar to those responsible for fractures of the sternum and are often accompanied by such a fracture or one of the scapula. Their site and severity naturally vary with the nature of the force causing them. In many cases they are compound and accompanied by injury to the lungs heart diaphragm liver or spleen. Surgical emphysema and intrathoracic hæmorrhage are common.

Fractures which are not compound or accompanied by internal injury should be treated by strapping on the lines laid down for fractures due to indirect violence Immediate operation is necessary in cases of compound fracture to prevent sepsis and avoid the danger of open pneumothorax injuries of the diaphragm liver or spleen must be treated at the same time Surgical emphysema though occasionally alarming is usually reabsorbed Pneumothorax will also in most cases disappear spontaneously if it is causing embarrassment to the heart or increasing in amount the positive pressure in the pleura may be reduced by inserting a needle through an intercostal space. A hæmothorax should be aspirated as soon as shock has subsided otherwise fibrosis and other complications are likely to follow (cf Chap XXIV p 478)

Fractures of the ribs due to indirect violence are more commonly encountered in practice They are caused by deformation of the thorax following blows falls or crushing accidents The ribs are broken at a point just in front of their angles The middle ribs the 4th to the 8th are most commonly involved and two or three are usually fractured together The line of fracture is oblique or transverse and there is rarely any displacement On this account an X ray may fail to demonstrate the injury

The patient complains of sudden pain at the point of fracture and of the sensation of something snapping The pain remains localised at the same spot and is increased by coughing or deep respiratory movements There may be shock and cyanosis but these are unusual On examination tenderness will be found at the point of fracture and pain is produced at the same site by compressing the whole thorax or by pressing on the injured ribs at some point distant from the site of injury These signs serve to distinguish a fracture from a bruise of the chest in which tenderness is noticed only on pressure at the site of injury

The fractured ribs should be immobilised by fixing the injured

side of the chest with bands of adhesive strapping These bands should pass from the nipple line on the sound side in front to the scapular line on the same side behind and in the vertical direction should extend from below the 12th rib to as high up as the axillary fold will permit They should be applied in the position of full expiration In the absence of any injury to the lungs the patient may be allowed to walk Union occurs in from four to five weeks

The first rib is occasionally fractured by forced depression of the shoulders the clavicle causing the damage Injury to the nerve of Bell with paralysis of the serratus magnus may complicate such a fracture A sling should be worn for three weeks.

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CHAPTER XLVII

DISEASES OF BONE

GENERAL CONSIDERATIONS.—The skeleton is composed of bones which have two main functions firstly to provide a rigid frame and thus to protect certain organs of the body from injury and secondly to afford attachments for the muscles and their tendons. The bones of the skeleton differ therefore in their shape and size according to the functions they have to perform. Every bone is composed of two types of osseous tissue the outer or compact bone and the inner or cancellous bone. *Compact bone* is composed of concentric plates or lamellæ which are arranged in relationship to the Haversian canals, these latter being occupied by small arterioles derived from the periosteal and medullary arteries. Since hard bone is incapable of expansion when inflammation occurs in these canals the vessels within are liable to be obliterated by pressure of the inflammatory products, and the blood supply is thus cut off with consequent death of the area of bone affected. *Cancellous bone* is composed of tissue arranged in the form of trabeculæ the direction and strength of which vary according to the strains and stresses to which the particular bone is subjected. Two types of trabeculæ are seen, pressure and traction, depending upon whether they are required to strengthen the bone against either body weight or the pull of muscles. The spaces between these trabeculæ are filled with bone marrow in which run blood vessels and lymphatics. Inflammation of the cancellous tissue and medullary tissue or marrow differs from that in compact bone in that the blood vessels are not so readily occluded and thus necrosis is less likely to result. The amount of each type of osseous tissue varies in each individual bone. In the flat bones the outer compact layers form two plates between which lies a small amount of cancellous tissue the best examples being the bones which compose the vault of the skull. In the short bones such as are found in the hands and feet a thin layer of compact bone is found covering or enclosing a disproportionately large amount of cancellous tissue. The long bones are made up of a shaft, which is composed of a tube of compact bone known as the *diaphysis* joined on in the child to two *epiphyses* by a disc of cartilage called the *epiphyseal cartilage*, at which level increase in length of the bone takes place. The shaft at either end close to the epiphyseal cartilage contains cancellous bone which diminishes as the middle of the shaft is approached. The cancellous spaces are occupied by a fatty marrow which is continuous with that in the medullary canal. From the medulla extend processes of connective tissue serving to provide a scaffolding by means of which the blood vessels are carried into the Haversian canals. Covering all bones is a vascular fibrous sheath known as the *periosteum* which varies in thickness according to the particular bone and the age of the patient. It can be easily separated from the underlying bone in children, but in adults it is more firmly attached. From this membrane pass blood vessels and lymphatics to enter the canals opening upon the surface of the compact bone. The periosteum is generally regarded now as being entirely a limiting membrane

which has no power of forming bone itself but this is a question upon which there is not universal agreement as some investigators still maintain that the periosteum is osteogenic This membrane is very firmly attached at the junction of the epiphysis to the diaphysis a matter of considerable importance when any acute inflammatory condition develops in the bone The *vascular supply* of a bone comes from two main sources —

1 **The Nutrient Artery** or main blood supply which passing through the compact bone via the nutrient canal, enters the medullary cavity where it proceeds to break up into two main branches which pass to either end of the bone terminating in a plexus at the *metaphysis (that part of the bone immediately on the diaphyseal side of the epiphyseal cartilage)* Besides supplying the medulla and the inner surface of the shaft of the bone branches are given off which enter the Haversian canals where they anastomose with small branches from the periosteal vessels.

2 **The Periosteal Vessels** *supply the outer layers of the* compact bone their branches anastomosing with those from the nutrient artery in the Haversian canals. Besides these two main sources, the junction of the epiphysis and the metaphysis is supplied with blood from the circulus vasculosus articuli, which is formed by the various articular arteries supplying the neighbouring joint

Development of Bone takes place either in (1) membrane or (2) cartilage The growth of a bone developed from cartilage occurs in three directions The shaft increases in length *by growth at the metaphysis* the amount varying at different situations Thus, in the lower limb an increase in length occurs principally on either side of the knee joint at the lower end of the femur and the upper end of the tibia, whilst in the upper limb increase in length occurs mainly at the *shoulder i.e.*, the upper end of the humerus and the wrist joint, *i.e* the lower ends of the radius and ulna Increase in breadth or thickness occurs by the deposition of new bone beneath the periosteum although this membrane itself probably does not lay down any new bone. The density of a bone is increased by the deposition of new bone in the Haversian systems and the surrounding lamellæ In bones which have been developed in membrane the power of regeneration should such a bone be destroyed, does not exist, but in those which are developed from cartilage the possibilities of repair are considerable

Certain developmental abnormalities occur in which one bone or any part of it may fail to develop. Nothing is known as to the factors which are responsible for such a failure Abnormal growth may occur producing gigantism, which is the consequence of an imbalance of secretions from certain of the ductless glands.

INFLAMMATION OF BONE

All inflammation of bone of whatever nature or however produced is properly known as an *osteitis* When the inflammation begins in or involves chiefly the cancellous or medullary tissue it is called an *osteomyelitis* Should the infection be limited principally to the periosteum and the underlying cortical bone it is known as a *periostitis* whilst an *epiphysitis* is an inflammation starting in and in the early stages being confined entirely to the epiphysis itself Whilst these terms are in themselves useful for many purposes it is impossible owing to the intimate vascular supply to imagine an infection of bone

being limited to any one part without the others being involved in some way

The *phenomena of inflammation* are essentially the same as those which develop in any other tissue except that in bone these are modified by its rigid structure Acute inflammation of bone produces engorgement exudation of fluid, emigration into the surrounding tissue of white cells and finally stasis but owing to the resistance which the rigid structure of the bone offers to their escape these products of inflammation accumulate as they are unable to drain away The pressure rises very rapidly in the Haversian canals and the



Fig 522

Long-standing acute osteomyelitis of the femur showing a large sequestrum, which has penetrated the knee joint. A strong involucrum has been formed.

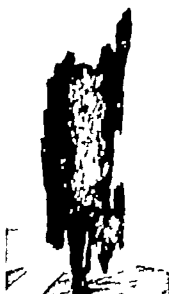


Fig. 523

A flake sequestrum from the surface of the femur as the result of a subacute periostitis. This can only occur if the endosteal blood supply is unaffected.

cancellous tissue thus obliterating the vessels so that the blood supply to the area of bone concerned is cut off As a direct result death of a portion of the bone occurs and this is called *necrosis* Its extent depends upon the degree of congestion in the bone at first it is impossible to define the area which has died but after some days the portion of necrosed bone becomes white in appearance and is gradually separated by granulation tissue from the bone which has survived the acute inflammatory process This separation is achieved at the expense of the dead bone which when separated from the living is known as a *sequestrum* (Figs 522 and 523) Its presence may be suspected from the existence of a persistent sinus leading from the skin down to the bone If such a sequestrum is allowed to remain for many months after [illegible] m from the healthy

bone its surface is gradually eroded by granulation tissue and becomes rough instead of smooth When an acute osteitis occurs the periosteum is separated from the bone first by oedema and then by the formation of an abscess (Fig 524) After this latter has been incised the space left is filled with granulation tissue and a layer of new bone is laid down beneath the periosteum This new bone which thus forms an ensheathing layer is called the *involucrum* having been formed by osteoblasts stripped off with the periosteum (Fig 525) It is irregular

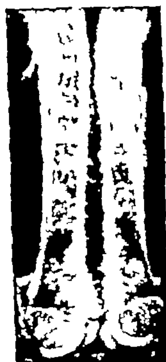


Fig 524

The femur of a child showing the early stages of osteomyelitis and the wide stripping of the periosteum. The trephine hole was made for drainage which proved inadequate and the child died.



Fig 525

An X-ray photograph showing a sequestrum of the tibia lying within the newly formed involucrum.



Fig. 526

An enormous exaggeration of the involucrum in an old long-standing case of osteomyelitis of the tibia. At the upper end is a cloaca, through which a sequestrum can be seen.

in formation and may be very thick, depending upon the duration of the inflammatory process Within it lies the sequestrum surrounded by granulation tissue and perforating it are several openings or *cloacæ* (Fig 526) which permit any discharge that may collect within the involucrum to escape to the exterior When the sequestrum has become completely separated it can be extracted by removing part of the involucrum. These changes are well illustrated in Fig 525

When the destruction and absorption of bone keep pace with the inflammatory reaction necrosis does not occur Absorption of the hard bone permits the exuded serum to escape so that the pressure around the vessels does not rise sufficiently to stop the circulation completely and thus bring about necrosis The bone is destroyed

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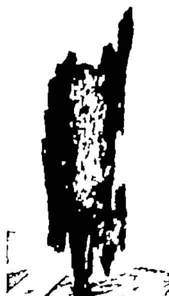


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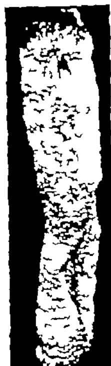


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When the *destruction and* absorption of bone keep pace with the inflammatory reaction *necrosis* does not occur Absorption of the hard bone permits the exuded serum to escape so that the pressure around the vessels does not rise sufficiently to stop the circulation completely and *thus bring* about necrosis The bone is destroyed

being limited to any one part without the others being involved in some way

The *phenomena of inflammation* are essentially the same as those which develop in any other tissue except that in bone these are modified by its rigid structure Acute inflammation of bone produces engorgement exudation of fluid emigration into the surrounding tissue of white cells and finally stasis but owing to the resistance which the rigid structure of the bone offers to their escape these products of inflammation accumulate as they are unable to drain away The pressure rises very rapidly in the Haversian canals and the



Fig 522

Long-standing acute osteomyelitis of the femur showing a large sequestrum, which has penetrated the knee joint A strong involucrum has been formed



Fig 523

A flake sequestrum from the surface of the femur as the result of a subacute periostitis. This can only occur if the endosteal blood supply is unaffected.

cancellous tissue thus obliterating the vessels, so that the blood supply to the area of bone concerned is cut off As a direct result death of a portion of the bone occurs and this is called *necrosis* Its extent depends upon the degree of congestion in the bone at first it is impossible to define the area which has died but after some days the portion of necrosed bone becomes white in appearance and is gradually separated by granulation tissue from the bone which has survived the acute inflammatory process This separation is achieved at the expense of the dead bone which, when separated from the living is known as a *sequestrum* (Figs. 522 and 523) Its presence may be suspected from the existence of a persistent sinus leading from the skin down to the bone If such a sequestrum is allowed to remain for many months after separation from the healthy

bone its surface is gradually eroded by granulation tissue and becomes rough instead of smooth When an acute osteitis occurs the periosteum is separated from the bone first by oedema and then by the formation of an abscess (Fig 524) After this latter has been incised the space left is filled with granulation tissue and a layer of new bone is laid down beneath the periosteum This new bone which thus forms an ensheathing layer is called the *involucrum* having been formed by osteoblasts stripp d off with the periosteum (Fig 525) It is irregular

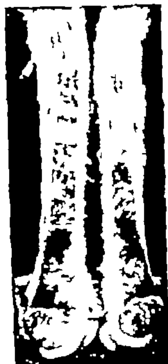


Fig 524

The femur of child showing the early stages of osteomyelitis and the wide stripping of the periosteum. The trephine hole was made for drainage which proved inadequate and the child died.



Fig 523

An X-ray photograph showing a sequestrum of the tibia lying within the newly formed involucrum.



Fig. 526

An enormous exaggeration of the in olucrum in an old long-standing case of osteomyelitis of the tibia. At the upper nd is a cloaca, through which a sequestrum can be seen.

in formation and may be very thick depending upon the duration of the inflammatory process Within it lies the sequestrum surrounded by granulation tissue and perforating it are several openings or *cloacæ* (Fig 526) which permit any discharge that may collect within the involucrum to escape to the exterior When the sequestrum has become completely separated it can be extracted by removing part of the involucrum These changes are well illustrated in Fig 525

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by the products of the inflammation and absorbed by osteoclasts at the same time so that there is a microscopic destruction in contrast to a massive destruction or necrosis this process being known as *caries* or rarefaction It is seen best in a tuberculous infection when the bone becomes fragmented and absorbed without the formation of a sequestrum When caries is accompanied by actual pus formation it is known as *caries suppurativa* whilst when it occurs without an abscess it is known as *caries sicca* a condition which is typically and most commonly seen in a tuberculous osteitis of the upper end of the humerus in old people when caries takes place in association with the formation of a well-defined sequestrum it is known as *caries necrotica* This is sometimes seen in a pure tuberculous osteitis but most often occurs if an acute pyogenic in fection is superimposed upon a tuberculous lesion.

When the inflammation in a bone subsides the processes of repair begin, and new bone is laid down either to replace that which has been destroyed or to strengthen what has been left undamaged. In an acute pyogenic infection it has already been said that the involucrum, when first formed, is large in amount and soft in texture If the inflammatory process becomes chronic this new bone hardens and *sclerosis* is now said to have taken place Sclerosis is best illustrated in an old syphilitic bone which may become as hard as ivory In chronic tuberculous conditions of bone sclerosis does not take place and any new bone which is formed is small in amount

ACUTE OSTEOMYELITIS

Ætiology —In nearly every instance acute pyogenic infection of bone is the result of invasion by the *S aureus* although occasionally the *S albus* streptococcus or pneumococcus may be responsible It is essentially a disease of children in the first decade of life though it may occur later In all such acute disease the infection is not confined to one particular portion of the bone compact and cancellous tissue medulla and periosteum alike being involved, but one part may bear the brunt of the infection It is seen most commonly in children of the poorer members of the population but as the result of the improved social conditions under which they live at the present day its incidence has dropped considerably so that it is now not only an uncommon disease but also a less virulent one The child who develops acute osteomyelitis is usually not in very good general health or else is recovering from one of the exanthemata Direct trauma is seldom the cause of the disease but a mild twisting strain is quite often a contributory factor by producing a hæmatoma in the metaphysis and thus enabling organisms to take hold and develop

Pathology —The infection, which is blood borne enters the bone by the nutrient artery in nearly every instance and passes to the metaphysis, the source of the infection being a septic lesion of the skin or throat In the metaphysis the organism produces an acute osteitis with abscess formation and destruction of cancellous tissue The pus which is formed at this site may spread in several directions (Fig 537) The

line of least resistance is into the medullary canal along which the infection travels for some distance though only exceptionally does the whole canal become affected As the result of this acute inflammation a certain amount of cortical bone may be destroyed and absorbed creating thereby a channel by which the pus can escape from the medullary canal to form an abscess beneath the periosteum which is thus lifted up from the underlying bone. In this way pus spreads some distance along the outer surface of the shaft The epiphyseal cartilage itself is very resistant to infection and prevents direct spread of disease from the metaphysis into the cancellous tissue of the epiphysis except under very exceptional circumstances When the epiphyseal cartilage lies within the cavity of a joint (as in the hip), an acute infection of the metaphysis is likely to burst through and produce thereby an acute septic arthritis If the disease starts in the epiphysis itself which is rare an acute epiphysitis results and the pathological process is exactly similar to that in any other situation, except that necrosis of the whole epiphysis owing to its limited blood supply is more likely and the joint is certain to become involved. Whilst any bone in the body may be the seat of an acute osteomyelitis certain bones appear more liable than others The lower end of the femur upper end of the tibia and of the humerus are situations in which it is most often seen. When it occurs in such bones as the vertebræ or the ilium the prognosis is more serious as the disease is likely to spread widely in the cancellous tissue before its presence can be recognised, and treatment by surgical methods is more difficult

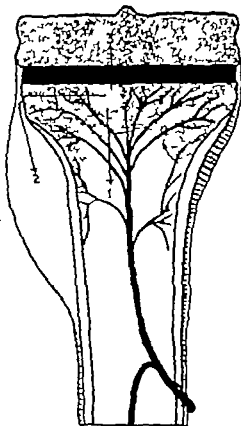


Fig. 637

Acute osteomyelitis

The blood supply of a bone is shown in red, viz., the nutrient artery and the many small periosteal vessels. A small abscess forms (green) beneath the epiphyseal cartilage (blue) 1 2 and 3 indicate possible methods of spread. 3 show a subperiosteal abscess which has destroyed the periosteal blood supply

Clinical Signs—The disease in nearly every instance starts suddenly with an attack of severe pain in the limb which is accompanied by a rise of temperature The child very soon is obviously ill, having a flushed face no desire for food and resenting any attempts to move or touch the limb There may be rigors and the temperature remains

in the region of 102° to 104 F accompanied by a rapid pulse T
tongue is dirty and if the infection is very virulent other signs
toxæmia soon show themselves the severity of which varies en
mously Beyond pain and tenderness in the limb there is of
very little else in the way of physical signs and a diagnosis of ac
rheumatism at this stage is liable to be made When the infect
process spreads into the medullary canal the toxæmia is much m
marked than it is when the disease remains more or less localised
the region of the metaphysis A blood count at this stage will sh
a leucocytosis up to 25 000 or more and in about 50 per cent. of patie
a blood culture will reveal the presence of the causative organism.
treatment is not instituted at once the signs of toxæmia become m
marked and the temperature will tend to rise to higher levels
may be possible to palpate an abscess over the end of the bone, a
the soft tissues around it will be swollen and œdematous whilst
neighbouring joint may develop a sympathetic effusion. Sho
the pus which has collected under the periosteum burst throu
this membrane the tension for the time being will be relieved a
the pain become less acute The temperature will also fall, only
rise again within a few hours as the tension returns At this st
of the disease an X ray is of no value Acute osteomyelitis in m
than one bone at the same time is seldom seen, although it is qu
common for the patient subsequently to develop subacute lesions
other bones during the period of convalescence In the fulminat
type of disease the whole shaft may be involved very rapidly so th
the diaphysis is filled with and surrounded by pus which strips t
periosteum completely off the bone

The *diagnosis* of acute infective osteomyelitis may present ma
difficulties It is often mistaken in the early stages for acu
rheumatism, but in this disease it is usual for more than one joint
be involved and in an acute osteitis the disturbance of the patien
general health is more marked. An acute septic arthritis may gi
rise to difficulty for the signs of the joint lesion may mask those
the underlying bone This is especially so in acute arthritis of the h
joint combined with osteitis of the neck of the femur Various acu
illnesses such as pneumonia, meningitis or any of the infectious feve
may suggest some local disease of a bone during their early stages. T
importance of making an accurate diagnosis is of even greater impo
ance at the present day for the introduction of penicillin has reduc
the necessity of surgical measures in a great number of patients

Treatment.—Although the discovery of penicillin has influenced t
treatment of acute osteomyelitis to such a great extent it must
remembered that if it is to supplant surgical interference entirely t
diagnosis must be made at once Otherwise surgical interference wi
the addition of penicillin therapy must remain the method of choice

In those instances where penicillin is used without any operati
treatment upon the bone it is wise to start with an intravenous injectio
following this up with intramuscular injections until all signs of acti
disease and toxæmia have completely disappeared. Splintage of t
affected limb is of course required at the same time In addition

curing the primary focus of bone infection penicillin may prevent other bones becoming infected When it is felt that surgical interference is called for the sooner this is carried out the better the quicker the tension within the bone is relieved the earlier will the signs of toxæmia subside and the less necrosis of bone will there be The affected bone is exposed and the periosteum incised if pus flows away freely it means that drainage is already established from the medullary cavity through the cortical bone and for the moment nothing further need be done Should no pus be present but merely an œdematous condition of the periosteum the metaphysis requires drilling with several holes to provide free drainage from the interior of the bone Free opening by guttering it and scraping out the contents of the medullary canal is not desirable this removes both diseased and healthy bone some of which may be quite capable of recovering from the effects of the inflammation together with medullary tissue which is often normal There is also the risk if not the certainty that when the bone is laid widely open healthy tissue will then become infected The only surgical aim in acute osteomyelitis is to provide free drainage for the abscess inside the bone in the same way that an incision through the skin provides drainage for any other abscess If therefore pus drains away freely when the periosteum is opened it shows that nature has already produced a channel from the infected area and that opening of the bone may not be necessary Removal of the whole diaphysis should be reserved for those patients in whom the condition does not show any signs of subsiding after the less drastic operation, or in the case of such a bone as the clavicle which cannot be drilled satisfactorily When the bone has been drilled the wound is packed with gauze to prevent hæmorrhage and the limb then splinted It does not matter what particular form of splint is employed, but in most instances plaster of Paris is the most convenient provided it is applied over a sufficient quantity of wool to absorb the discharge which takes place If the condition of the patient is satisfactory and the pulse and temperature are maintaining a lower level this dressing should not be touched until the smell is no longer tolerable With the help of deodorant bags this may be as long as four weeks If it is found that penicillin does not control the infection or that the organism is resistant to this agent then sulphathiazole should be given in its place The plaster must be removed immediately if any of the complications explained on p 127 should occur Should the neighbouring joint become infected it will require aspiration and perhaps even drainage and fixation in a Thomas s or some other suitable splint Very occasionally it will be found necessary to perform an amputation to cut short the disease and save life but in such grave cases the child is probably suffering from a septicæmia when even amputation is a last resort and unlikely to save life When all signs of acute infection have subsided the limb will be left with one or more discharging sinuses which lead down through the involucrum to the portion of bone which has necrosed and is in the process of separating off as a sequestrum This separation may take two or three months before it is complete but as soon as it has occurred the sequestrum should be removed by cutting an opening through the

involucrum large enough for the purpose At the same time sufficient of the latter needs to be excised to enable the soft tissues to fall in and fill up the cavity for unless this happens the cavity will continue to discharge in spite of the fact that the sequestrum is no longer there Such a limb requires complete rest in the recumbent position after operation if it is to have any chance of healing

The *prognosis* of acute osteomyelitis is always serious, but the advent of penicillin has served to reduce its terrors and even if the bone has to be explored and drilled the subsequent course of the disease is much more favourable In the bones of the skull vertebræ and ilium the prognosis both as regards life and ultimate healing is bad for the infection is liable to spread, in spite of surgical measures in the loose cancellous tissue which is present Further none of these bones possess any great power of response to inflammation by the formation of an involucrum, and if a portion of one of them is destroyed seldom is any effort made to replace it Sulphathiazole is still of value in those patients whose infection is not influenced by penicillin.



FIG 628
A ring sequestrum removed from an amputation stump.

ACUTE EPIPHYSITIS

Acute epiphysitis is a disease of infancy and is most commonly seen in the head of the femur being always complicated by an associated acute arthritis of the hip joint With early penicillin therapy or by efficient drainage combined with fixation and extension the chances of recovery as regards life are excellent The hip joint is likely to be permanently damaged and the epiphysis is either partially or completely destroyed. The acetabulum is also damaged, but to a less extent than the head of the femur The stump of the neck becomes dislocated upwards and posteriorly upon the ilium unless adequate measures are taken to prevent this and these are not easy in an infant The abscess which generally forms shows itself on the posterior aspect of the joint in most cases The clinical signs are those of an arthritis, viz pain loss of function and general illness the joint being held rigidly fixed by muscular spasm in flexion and adduction The child in after life has a limp which varies according to the amount of destruction of bone but has quite good movement in the false joint which has formed. There will be about an inch or an inch and a half of shortening Occasionally operative treatment is desirable in later life to stabilise this damaged joint and reduce strain on the lumbar spine

ACUTE TRAUMATIC OSTEOMYELITIS

This condition which occurs as the result of a compound fracture should at the present day be seldom seen provided the wound is adequately cleaned out within a few hours the fracture reduced and

splinted whilst a course of penicillin is instituted at once It may occur after an amputation of a severely infected limb and then is likely to result in the formation of a ring sequestrum (Fig 528)—but this is rare at the present day

In all types of acute infection of bone the patient is liable to develop a septicæmia or pyæmia with the risk of other bones being involved

CHRONIC INFLAMMATION IN BONE

Chronic Pyogenic Infection of Bones

This may follow an acute attack of inflammation and continue for many years (Fig 529) but is likely in the future to be much rarer owing to the treatment of acute osteomyelitis being so much more satisfactory It also results from a bone infection which was never virulent enough to produce an acute abscess In any chronic osteomyelitis the amount of discharge will depend upon the size and number of the sequestra present and upon the extent of the cavity which contains them The longer a chronic inflammation continues the thicker and more sclerosed does the involucrum become



Fig. 529

Chronic osteomyelitis of the tibia involving the whole shaft The raising of the periosteum and the formation of new bone are clearly shown

The commonest form of chronic osteomyelitis which develops without any previous acute signs is a Brodie's abscess (Fig 530) Described originally by Brodie as a tuberculous abscess of bone it has since been proved in most instances not to be so though quite often it is impossible to make a definite diagnosis except by bacteriological methods It is generally caused by a *S aureus* of low virulence which can be cultured in a pure strain from the pus except in old-standing cases when the cavity will be found to contain a clear yellowish coloured fluid which on culture is sterile Absorption of bone has taken place without any active signs of inflammation and around the cavity there is some sclerosis Lining its wall there may be a thick pyogenic membrane while in a very chronic lesion this lining resembles a serous membrane Occasionally the cavity will contain a few small sequestra No history of any accident is usually obtained. In the course of time



Fig. 530

The lower end of the femur containing a Brodie's abscess. The sclerosis is well shown.

such a bone abscess if the infection is still active gradually enlarges when the contents become sterile the cavity ceases to increase in size but does not fill up with new bone formation. A Brodie's abscess develops in children but is quite often not recognised until adolescent life The site of the abscess like all pyogenic infections of bone is found in the metaphysis of the long bones especially at the lower end of the tibia A Brodie's abscess by the time it is discovered, may be situated some distance from the metaphysis where it originally began as the result of growth having taken place at the epiphyseal line

When a chronic osteomyelitis continues for any length of time the presence of this inflammatory process close to the epiphyseal cartilage induces a constant increase of blood supply to the affected bone and thereby produces an increased growth in the bone which becomes longer than the corresponding bone on the other side



FIG 531

A X ray photograph of a Brodie's abscess in the upper end of the tibia

Clinical History—Pain of a dull aching nature intermittent in character may be the patient's only complaint. On some days it may be entirely absent and on others especially after use of the limb it may become worse but is never serious Little may be thought of it at first and its recurrence be the only reason for further investigation. Examination may reveal some tenderness over the affected bone with perhaps a little thickening but unless the two limbs are very carefully compared it is quite easy to overlook the few signs present If the condition becomes more acute the pain will increase and some œdema develop which will subside with rest leaving a slight increase in thickening X-ray examination reveals the true nature of the condition (Fig 531)

Diagnosis—In a case of chronic bone abscess it may be very difficult to arrive at a definite diagnosis by clinical examination. The X ray picture will in most instances enable a correct diagnosis to be made If the lesion is tuberculous no sclerosis will have taken place around the cavity perhaps some minute carious sequestra may be seen and a diffuse decalcification of the bone-end is generally present If the infection is caused by a pyogenic organism the cavity is surrounded with a thin ring of denser bone whilst if syphilitic the cavity will be encircled by dense bone and the whole circumference

and thus enable it to heal up Provided this is carried out thoroughly there are very few chronic cases which cannot be made to heal although it may need several months care before this occurs The prognosis however has improved since the advent of penicillin The only trouble is that if at a subsequent date the patient s general health is impaired or the limb injured even years afterwards there is always a risk of a recrudescence of the inflammation. Should this happen drainage of the abscess with splintage until the incision has healed is all that is necessary Treatment of a Brodie s abscess consists in opening the bone to allow the pus to escape Its contents are cleared out the sides of the bony cavity shelved off and the incision closed the limb subsequently being fixed in plaster to maintain complete rest until it is soundly healed Many Brodie s abscesses heal by first intention with this treatment and even if this desirable end is not achieved and a small sinus results, it will heal up provided the limb is rested All patients with chronic osteomyelitis requiring operation should be given penicillin as a protection the original organisms being likely to be made active by surgical measures used to remove sequestra

Typhoid Osteitis

Infection of bone by the typhoid bacillus is a rare condition which may occur during the period of convalescence or not until many years after the acute attack of fever The portion of bone affected lies just beneath the periosteum a small abscess forms and sometimes slight destruction of the superficial layers of the compact bone may take place The bone which is most often the seat of this form of osteitis is the tibia the disease starting on its subcutaneous surface about the middle of its shaft The ribs also may be the site of a typhoid osteitis The onset of symptoms is insidious, beginning with pain and tenderness in the bone with intervals in which there is a remission of these symptoms After a time the pain becomes more persistent and œdema with redness of the overlying skin develops X ray examination may reveal a small cavity upon the surface of the bone just beneath the periosteum

Treatment —In some cases rest alone will suffice for the condition to settle down but when an abscess has actually formed it requires incision to let the pus out although a sinus is liable to form and may take many months to heal. In typhoid osteitis of a rib it is wiser to resect the diseased rib so that more rapid healing may be obtained

TUBERCULOUS DISEASE OF BONE

Infection of bone by the tubercle bacillus which may take several forms is always secondary to disease elsewhere and is only one manifestation of a general infection the primary focus being in most instances either in the mesenteric or bronchial glands in children and in the lungs in adults The condition develops very slowly and by the time symptoms are complained of it has already been present some time Tuberculous osteitis is more often than not associated with an arthritis of some nearby joint

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Diagnosis—In a case of chronic bone abscess it may be very difficult to arrive at a definite diagnosis by clinical examination The X ray picture will in most instances enable a correct diagnosis to be made If the lesion is tuberculous no sclerosis will have taken place around the cavity perhaps some minute carious sequestra may be seen and a diffuse decalcification of the bone-end is generally present If the infection is caused by a pyogenic organism the cavity is surrounded with a thin ring of denser bone whilst if syphilitic the cavity will be encircled by dense bone and the whole circumference of the bone increased in size A Wassermann test will assist in the diagnosis but in a certain number the differentiation between a pyogenic and a tuberculous infection will not be possible until after the bone abscess has been opened

Treatment of chronic osteomyelitis consists in a wide exploration of the affected bone with removal of any sequestra present, combined with a shelving of the sides of the cavity so as to render it shallow

and thus enable it to heal up Provided this is carried out thoroughly there are very few chronic cases which cannot be made to heal although it may need several months care before this occurs The prognosis however has improved since the advent of penicillin The only trouble is that if at a subsequent date the patient s general health is impaired or the limb injured even years afterwards there is always a risk of a recrudescence of the inflammation Should this happen drainage of the abscess with splintage until the incision has healed is all that is necessary Treatment of a Brodie s abscess consists in opening the bone to allow the pus to escape Its contents are cleared out the sides of the bony cavity shelved off and the incision closed the limb subsequently being fixed in plaster to maintain complete rest until it is soundly healed Many Brodie s abscesses heal by first intention with this treatment and even if this desirable end is not achieved and a small sinus results it will heal up provided the limb is rested All patients with chronic osteomyelitis requiring operation should be given penicillin as a protection the original organisms being likely to be made active by surgical measures used to remove sequestra

Typhoid Osteitis

Infection of bone by the typhoid bacillus is a rare condition which may occur during the period of convalescence or not until many years after the acute attack of fever The portion of bone affected lies just beneath the periosteum a small abscess forms and sometimes slight destruction of the superficial layers of the compact bone may take place The bone which is most often the seat of this form of osteitis is the tibia the disease starting on its subcutaneous surface about the middle of its shaft The ribs also may be the site of a typhoid osteitis The onset of symptoms is insidious beginning with pain and tenderness in the bone with intervals in which there is a remission of these symptoms After a time the pain becomes more persistent and oedema with redness of the overlying skin develops X ray examination may reveal a small cavity upon the surface of the bone just beneath the periosteum.

Treatment —In some cases rest alone will suffice for the condition to settle down, but when an abscess has actually formed it requires incision to let the pus out although a sinus is liable to form and may take many months to heal In typhoid osteitis of a rib it is wiser to resect the diseased rib so that more rapid healing may be obtained

TUBERCULOUS DISEASE OF BONE

Infection of bone by the tubercle bacillus which may take several forms is always secondary to disease elsewhere and is only one manifestation of a general infection the primary focus being in most instances either in the mesenteric or bronchial glands in children and in the lungs in adults The condition develops very slowly and by the time symptoms are complained of it has already been present some time Tuberculous osteitis is more often than not associated with an arthritis of some nearby joint

TUBERCULOUS PERIOSTITIS

The disease starts in the bone just beneath the periosteum and not actually in this membrane itself The process consists in the development of typical tubercles with formation of granulation tissue and caseous material. As a rule there is little destruction of bone though an abscess with characteristic caseation is likely to form between the bone and the periosteum. This may burst through the periosteum and form a cold abscess which will in time involve the skin and lead to a sinus The ribs tibia, ulna (Fig 532) and lower end of humerus are most commonly involved Whilst such a condition may take several months to develop sometimes in young children it may be a matter only of weeks especially if there are multiple lesions. X rays may reveal in the ribs a carious condition of the bone, but in the tibia ulna and humerus a good deal of new subperiosteal bone is often formed. The chief clinical sign is the appearance of a swelling which is tender on pressure When in association with a rib the swelling in most cases rapidly increases in size and a cold abscess is formed.



FIG 532

Tuberculous periostitis of the ulna forming a small subperiosteal abscess.

The *diagnosis* may be very difficult in children, especially in the tibia for an X ray shows a periostitis very similar in many respects to that seen in syphilis. Clinically the swelling may in the early stages feel firm and not unlike a sarcoma, but the X ray will differentiate between a growth and tuberculous periostitis If an abscess is present aspiration of the contents will confirm the diagnosis as the tubercle bacillus can always be found provided sufficient time and trouble are taken in looking for it if further confirmation is needed the pus may be injected into a guinea pig

Treatment —Beyond aiming at improving the general resistance of the patient and dealing with any abscess which may develop there is little to be done except in disease of a rib Here the cancellous bone very rapidly becomes infected, and treatment should aim at removing all the diseased bone by excising the affected portion of the rib A sinus will persist for a little time but the prognosis as regards recovery is good

TUBERCULOUS OSTEITIS

This is the most common form of disease in bone produced by the tubercle bacillus and it develops in the cancellous tissue in either the

metaphysis or the epiphysis itself Most common in children it is also seen in adults when the diagnosis may be more difficult

Pathology—The bacillus is deposited in most cases in the same soft new bone at the metaphysis close to the epiphyseal cartilage in which an acute infective osteitis commences The pathology is in all respects similar to the development of a tuberculous lesion in any other tissue and caries of the bone is produced by this process The formation of sequestra is rare but when they do occur they are small soft and friable and lie in a mass of tuberculous caseous granulation tissue Sclerosis of the surrounding bone is limited in degree for the tuberculous process seems to inhibit the formation of bone rather than stimulate it as do most other chronic infections Occasionally a large sequestrum is formed lying in a mass of granulations and caseating material This condition is known as *caries necrotica* and such a sequestrum must be removed before the lesion itself will heal Whilst a tuberculous osteitis may remain more or less encysted for a consider able length of time it tends slowly to progress and by destroying the surrounding bone reaches the periosteum and forms an abscess which strips this up from the bone Owing to its close proximity to a joint there is always the liability of the epiphysis becoming involved thus entailing the danger of infection spreading directly into the joint and producing a tuberculous arthritis An acute tuberculous osteitis spreading rapidly along the shaft of a bone is occasionally seen. In young infants the short bones of the hands and feet are very liable to become the seat of this form of disease The outstanding clinical sign of a tuberculous osteitis is similar to that of a Brodie s abscess namely a dull aching pain which is intermittent in character Unless the diseased bone is superficial no local signs will be detected for there is neither œdema nor redness of the skin and the condition may not become manifest until the adjacent joint shows signs of involvement

When the phalanges or metacarpals are affected the condition is known as tuberculous dactylitis. A portion of the finger or toe becomes enlarged fusiform in outline and painful Within a short period the skin over the affected bone appears smooth and shiny and the pain more constant whilst before long it becomes red and tender and an abscess forms The disease commences in the cancellous tissue of the phalanx producing a typical erosion or caries and the compact bone then becomes involved. As this is destroyed, new bone is laid down beneath the periosteum making it appear that the bone has been expanded. In many patients this form of tuberculous osteitis involves more than one bone at the same time and although it may settle down quietly an abscess forms in the majority of cases Inter ference with growth commonly occurs leaving the affected finger shorter than the others.

The prognosis as regards this particular lesion is good Occasionally it may become quiescent without any abscess developing but even if this latter does form and burst it always heals up when the underlying disease in the bone has resolved Sometimes a fair-sized sequestrum is formed and may require removal. Whilst fixation upon a splint or in plaster is in theory desirable in practice it is difficult to carry out

on account of the size of the child's finger and the condition does not appear to suffer from failure to immobilise the digit.

After the phalanges the bones of the tarsus are most often the seat of a tuberculous osteitis but here owing to the proximity of the tarsal joints such a focus of disease is more liable to produce serious consequences in that these joints are almost certain to become infected. The scaphoid os calcis or cuboid are the favourite sites of infection. Disease in these bones is always accompanied by an abscess which may discharge through the skin to the exterior or into the joints of the tarsus A sinus will develop and may continue to discharge for many months but with infants treated under good conditions in the country such a track always heals eventually The condition of *caries necrotica* is seen most often in the tarsal bones and removal of the sequestrum which is formed becomes necessary before the lesion will heal Under modern conditions such a tuberculous osteitis usually does well and in the child amputation should hardly ever be necessary though in the adult this must as in disease of the ankle joint often remain the method of choice

SYPHILITIC DISEASE OF BONE

Syphilitic disease of bone in all its forms is comparatively rare at the present day in consequence of the much improved methods of treatment which have been employed in dealing with early syphilis during this century These lesions vary somewhat in congenital and acquired syphilis

Acquired Syphilis

The disease may manifest itself in several ways (1) osteoscopic pains (2) periostitis (3) diffuse osteitis and (4) gummata.

1 **Osteoscopic Pains** occur in secondary syphilis especially in the bones of the lower limbs They are of little importance and rapidly disappear as the patient comes under the influence of treatment. They are due to a transient subacute periostitis

2 **Periostitis** occurs in the late secondary and early tertiary stages in which a localised inflammation of the periosteum and bone beneath develops There is an area of tenderness over the affected portion of the bone which becomes painful at night when the limb gets warm in bed. It is seen most commonly on the subcutaneous surface of the tibia and appears to develop in many instances after some minor injury Such a periostitis usually clears up leaving little permanent change but sometimes in the process of repair a certain amount of new bone is laid down which becomes sclerosed thus forming a *periosteal node* (Fig 533)

In later tertiary syphilis periostitis instead of being localised in this way to one small portion of the bone, may involve the whole shaft the middle of which is affected more extensively than either end.

3 **Diffuse Osteitis.**—This is the most common type of lesion in the tertiary stage It may be associated with the formation of gummata and a considerable periosteal inflammation or may be a pure diffuse osteitis The condition starts in the middle of the shaft and spreads

to either end The bone gradually becomes very much thickened and sclerosed and the medullary cavity obliterated The tibia is the most frequent site the bone becoming bowed anteriorly In consequence of the sclerosis the vessels in the Haversian canals are constricted and this, together with the obliterative endarteritis which is present in all tertiary lesions interferes with the blood supply to such an extent that necrosis of bone is liable to occur Should a pyogenic infection subsequently be superadded sequestra will form and may take a long time to separate Such a diffuse osteitis occurs most commonly in children



FIG. 533

Syphilitic periosteal node at the upper end of the tibia, the rest of the bone being normal.



FIG. 534

Generalised periostitis of the ulna due to congenital syphilis in a young child.

affected with congenital syphilis, when the typical sabre tibia is produced

This diffuse osteitis when it involves the nasal bones in infants is nearly always complicated by a secondary pyogenic infection and the purulent discharge from the nose and the marked damage to bone is due to this as much as to the *syphilitic osteitis* In the cranium a diffuse osteitis is often associated with a superficial gumma which is likely to burst on the surface and become secondarily infected after which necrosis occurs in the sclerosed bone

Gummata.—Gummatous changes may show themselves in several ways —

1 In association with a diffuse osteitis

2 *Subperiosteal* —These may be either single or multiple and they are seen most often in the sternum, the skull and the hard palate

When they burst and discharge their contents they are liable to become secondarily infected and extensive necrosis of bone will occur Around this necrosed bone the sclerosis which takes place may prevent the sequestrum from separating and the ulcers may continue discharging for several years. In the skull the pericranium surrounding the necrotic area becomes gummatous and at the same time the subjacent bone undergoes sclerosis.

Periosteal gummata are also seen in the hard palate where they reveal themselves as painless soft swellings which after rupture leave an area of necrosing bone After the sequestrum has separated there remains a perforation of the palate which results in a direct communication between the nasal and buccal cavities

3 *Central or Localised Gummata* may be seen in acquired syphilis, but are most common in children with congenital disease This central gumma develops quite insidiously in children of about 10 to 12 years of age in the cancellous tissue of the metaphysis at the ends of long bones especially the upper end of the tibia. A carious condition of the bone is produced resembling in many ways a tuberculous osteitis or a Brodie's abscess and, should it be accompanied by new bone formation beneath the periosteum, it may closely simulate an osteogenic sarcoma. The site at which such a gumma develops is close to the epiphyseal cartilage and the neighbouring joint is sometimes distended by a painless effusion

Clinically the swelling of the joint may be the only obvious sign and the sole evidence of any osseous disease is that the patient complains of a dull ache in the end of the bone Often no other sign of congenital syphilis is present The absence of severe pain and of any characteristic findings in an X ray should raise the suspicion of syphilis. The diagnosis from tuberculous osteitis and Brodie's abscess should be easy as in the latter there is always a certain amount of surrounding sclerosis An early sarcoma, before any periosteal bone has been formed may give rise to difficulty in diagnosis If the Wassermann reaction is negative the diagnosis can be decided only by watching the effect of antisyphilitic treatment Mercury by mouth or in the form of inunction combined with potassium iodide will produce a most rapid alteration in the bone picture In congenital syphilis other manifestations of the disease may be apparent though this is not always so the central gumma perhaps being the only syphilitic lesion

Congenital Syphilis

Various other bone lesions due to infection by the *Treponema pallidum* which are peculiar to congenital syphilis are seen, though they are very rare at the present day

1 **Periosteal.**—The formation of bone beneath the periosteum of the frontal and parietal bones occurs producing thereby the so-called Parrot's nodes (Fig 535) and these by their situation around the anterior fontanelle give rise to what is known as the "hot cross-bun" appearance of the skull In the early stages this new bone formation is soft and if treatment is given will almost entirely disappear but

if left it becomes dense and sclerosed and remains as a persistent deformity

2 **Craniotabes** consists in absorption of the bony tissue of the cranium so that the bones are thinner It occurs during the first six months of life

3 A **gummatous osteitis** may develop in the phalanges producing a **dactylitis** very similar in appearance to that seen in tuberculous osteitis of the fingers The progress of the disease is often quite free from pain but as often as not it ends with a discharging sinus which may take some time to heal.

4 **Symmetrical Overgrowth** of the tibiæ occurs together with periosteal nodes The length of the tibia is out of proportion to the length of the femur This condition was described by Clutton, who observed it in association with the painless synovitis of the knee joint which bears his name

5. **Epiphysitis** or syphilitic osteochondritis was at one time a fairly common lesion in infants with congenital syphilis but it is very rare at the present day It consists in a gummatous infiltration of the epiphyseal cartilage with the formation of osteoid tissue so that as a result of an obliterative endarteritis the vascular tissue in this situation becomes replaced with a yellowish material and later by granulation tissue In consequence a separation of the epiphysis though it rarely happens may take place When the epiphysis does separate the limb hangs useless in a condition known as syphilitic pseudo-paralysis Under these circumstances secondary suppuration has been known to occur This particular epiphysitis develops about the third month and it is characterised by an enlargement of the epiphysis which in contrast to rickets involves to some extent the diaphysis It is nearly always symmetrical and as in rickets the wrists knees and ankles are the sites most commonly involved.



FIG. 535
Congenital syphilis. Gumma of frontal bone

In addition to the enlargements at the ends of bones there are tenderness and pain on attempted movement An X ray of the affected portion will show irregularity and widening of the epiphyseal line but no characteristic feature The diagnosis should usually be easy as the condition develops in an infant at an earlier age than rickets and the Wassermann reaction is always positive Scurvy is likely to occur in a child of about the same age but the absence of hæmorrhage from the gums and in other situations should simplify the diagnosis

Clinically the appearance is characteristic. The vault of the skull develops normally but owing to the abnormal ossification of the base it is very much out of proportion whilst premature synostosis of the sphenoid results in a depression of the bridge of the nose not unlike that seen in congenital syphilis. The limbs are stunted in comparison with the trunk, and the epiphyses at the ends of the long bones are enlarged, giving an appearance very similar to that of rickets while the diaphyses are shortened The fingers are spread widely apart owing to divergence of the metacarpal bones producing the so-called "trident hand" The child stands with a marked lumbar lordosis owing to the presence of a coxa vara These children are perfectly healthy both bodily and mentally and apart from their diminutive stature develop in a normal fashion. No treatment has any influence upon the development of the bones Many of these children later in life earn their living in a circus or on the stage as comedians

ACROMEGALY

Acromegaly is an uncommon condition which affects principally the bones of the skeleton in young adults It results from an hyperplasia or adenoma of the anterior lobe of the pituitary body the increased secretion of which produces a symmetrical overgrowth of the skeleton The hands and feet are enlarged and thickened and the bones hypertrophied Should the disease commence before the epiphyses have united, there may be a great increase in length of the shafts of the bones and many giants are excellent examples of this condition The forehead and orbital ridges are prominent and the nose is enlarged and broadened Both the upper and lower jaws become very prominent and the lower lip thickened and overhanging the whole facial expression being most unpleasing

X rays will reveal an enlargement of the sella turcica and, in consequence of the proximity of the optic chiasma an optic neuritis with partial loss of the visual field is a common complication

A patient with this disease generally suffers from headaches lassitude and a tendency to sleep excessively the appetite both for solids and fluids also being above the normal. Loss or diminution of sexual power is usual in men and amenorrhoea develops in women The progress of the disease is very gradual but by the time it has fully developed the whole aspect of the patient is characteristic

Treatment is of little value and entirely symptomatic The removal of the tumour of the anterior lobe of the pituitary will at times produce an improvement at any rate in the field of vision should this be seriously affected but the mortality of the operation is a deterrent factor

OSTEITIS DEFORMANS OR PAGET'S DISEASE

This condition described originally by Sir James Paget is a disease in which there is softening and enlargement of certain portions of the skeleton followed by bending and hardening with which is associated a considerable amount of bone pain Although it may start in young adults it is most often seen in men of about fifty years of age women

being less often affected. Its etiology is quite unknown but it is generally considered to be a chronic inflammatory condition which at first leads to a decalcification and softening of the bones concerned. This softening is followed by a hypertrophy and thickening of the bones which again become calcified being then very much enlarged and deformed (Figs. 541 and 542). Whilst at first this osteitis may be localised to only one portion of the bone it gradually spreads and the medullary cavity eventually becomes entirely obliterated. Any of the bones of the skeleton may be affected but there appears to be a predilection for the tibia, femur, vault of the skull and bones of the

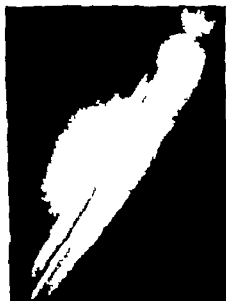


Fig. 541

Early radiographic changes in osteitis deformans.



Fig. 542

Late changes in osteitis deformans.

pelvis. It may begin in one tibia many years before any other bone shows a sign of the disease.

The first change is an alteration of the bony trabeculæ, *which lose* their normal arrangement. The compact bone becomes thicker though its density is much diminished, and the periosteum is hypertrophied. As the disease progresses these softened bones bend but later regain their rigidity as they harden up. The tibia is much thickened, more especially in the upper part, and then bends. The skull bones are also thickened. *If* a chronic osteitis, the nature of which is obscure, commences in *one bone* the diagnosis may often be settled by X-raying the skull or pelvis, which will reveal the mottled appearance so characteristic of this disease. The enlargement of the skull will result in the patient's need to buy hats of constantly increasing size. When the disease has become fairly general he stands with a rigid kyphosis, the head carried well forwards and the lower limbs bowed anteriorly. As the *condition progresses* he loses height and becomes

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so bent up that walking is difficult Although the vault of the skull is so commonly affected in this disease the facial bones seldom show much change The patient complains as a rule only of pain in a bone or bones This may get gradually worse and at times be almost intolerable Fractures seldom occur but should they do so union takes place satisfactorily An osteogenic sarcoma is peculiarly liable to develop in a patient who has suffered from this disease for many years, and such growths which are of the spindle-celled variety have the usual prognosis associated therewith Death, apart from the development of a sarcoma, takes place from some other disease and these patients, owing to the rigidity of their chests are very liable to develop pulmonary complications.



FIG 543
Osteitis fibrosa in the lower end of the femur

FIG 544 (inset).
Osteitis fibrosa in the inner end of the clavicle

Treatment — Nothing will stay the progress of osteitis deformans but it may take many years to develop to the stage when the patient presents the classical appearances The pain may be relieved by certain measures, such as small doses of thyroid and X rays which occasionally give relief If the pain becomes so bad that the patient is prevented from sleeping at night and from walking about guttering of the shaft to relieve the intramedullary tension will sometimes give considerable relief at any rate for a time whilst if the tibia is much bowed an osteotomy will correct the alignment and at the same time relieve the pain Fractures if they occur require treatment in the usual manner until union is firm When a sarcoma develops amputation or treatment by X ray therapy may be called for to relieve pain. Death takes place as in any other growth of this nature from metastases in the lungs

OSTEITIS FIBROSA

Osteitis fibrosa or fibrocystic disease of bone was first described by von Recklinghausen in 1891 It is characterised by the formation of cavities in the bone the cancellous tissue and medulla being absorbed and replaced by a vascular tissue containing giant cells which lines the walls of the cysts (Figs 543 and 544) These are formed by the absorption of blood from the sites in this tissue where hæmorrhages

have taken place It occurs in children or young adults and two types are seen

1 **The Solitary Bone Cyst** met with in long bones especially at the upper end of the femur or the upper half of the shaft of the humerus Slight pain may call attention to its presence and this is revealed by an X ray which shows a clear area in the centre of the affected bone with thinning of the cortex. Again a spontaneous fracture may occur with little or no violence in a bone which has been unsuspected of being in any way abnormal (Fig 545)



Fig 545

X ray appearance of a single cyst in the upper end of the humerus, which has successfully united after a pathological fracture.

Treatment —When a fracture occurs through such a cyst union may take place without any trouble and the cyst is thereby cured If however this does not happen or the cyst is discovered by X-ray the bone must be exposed and its contents curetted out Bone grafting to fill up the cavity may hasten a cure but is not essential.

These cysts may contain blood and be lined by a vascular membrane containing typical giant cells of the osteoclast type or they may be filled with a clear yellow fluid



Fig 546

A radius showing the changes due to osteitis fibrosa in the greater part of its [illegible] and union after fracture

2 **Generalised Osteitis Fibrosa.**—This type of disease is very rare It may affect any of the bones but usually starts in one months or years before any other shows evidence of being affected. It differs from the solitary bone cyst in that it is associated with changes in the parathyroids *In* some patients the adenoma of the parathyroid can be palpated, but it is not usually discovered until an exploration is carried out As the result of its excessive secretion calcium is absorbed from the bones into the blood stream the content of which rises to as much as 16 mg per 100 c c

Pain in a bone calls attention to the condition which is revealed by X ray Spontaneous fracture may occur as in the solitary cyst and unites in the same way (Fig 546) Exploration of the cyst shows it to contain a clear yellowish fluid, but curettage alone does not cure the lesion which may progress in the surrounding bone Treatment consists in exploration of the parathyroids and removal of the adenoma, after which the disease of the bones will

automatically improve Medical treatment otherwise has no influence upon the disease

FRAGILITAS OSSIUM OR OSTEOGENESIS IMPERFECTA

Fragilitas ossium is a congenital disease of bone in which there is a liability to the occurrence of fractures on the slightest provocation. It appears to develop in early childhood (Fig 547) but is occasionally present in a new born infant. *There is a defective development of the* compact tissue so that the bones are brittle and shell-like Nothing is known as to its causation The fractures which occur are painful but similar to others except that they unite very slowly and then in a bad position if they have not been splinted continuously When first seen these children have usually had many fractures and apart from the fact that their sclerotics are sky blue in colour little else is to be found. The diagnosis of fragilitas ossium is not usually made until several fractures have been sustained (Fig 548) Many of these infants die when quite young but others appear to outgrow their tendency although they are liable to be left with distorted and atrophic bones which are quite incapable of fulfilling their normal function



FIG. 547

A small child with multiple deformities following fractures in fragilitas ossium.



FIG 548

X ray picture of the child in Fig 547

No treatment beyond that of the fractures is of any value Many extracts of the ductless glands have been tried but they have no influence upon the condition of the bones

OSTEOCHONDRITIS

Osteochondritis is a condition affecting certain bones during the period of growth of which little or nothing is known either as to etiology or pathology It is supposed by some to be a mild chronic infective process whilst others consider it to be a response to some slight trauma, which produces an interference with the blood supply of the affected portion of bone In none of the variety of conditions which can be grouped under the title of osteochondritis does suppuration ever take place and therefore it is probable that the suggestion of trauma as the primary cause is the more likely one

PSEUDOCOXALGIA

Perthes disease is an affection of the hip joint seen in children between the ages of 5 to 10 years In its signs and symptoms it much

resembles a tuberculous arthritis and up to thirty years ago was always diagnosed and treated as such Nothing is known as to its etiology or pathology but it is certainly not a tuberculous condition

The child who is fit and well nourished is found to have developed a limp and to complain of a pain in one hip joint The onset is insidious and seldom is there any history of an accident even of the most trivial nature such as is common in a child of this age The patient is a boy more often than a girl



Fig 549

A boy illustrating the limitation of abduction during flexion of the hip which is so characteristic a sign of pseudocoxalgia.

Clinical Signs—Examination shows a perfectly healthy child who walks with a limp The movements of the hip joint unlike those of a tuberculous arthritis are not limited in every direction. Flexion is nearly full in range whilst abduction in flexion is very much limited if not entirely abolished (Fig 549) All the other movements are restricted in range as the result of involuntary muscular spasm The great trochanter is more prominent on the affected than on the sound side and a fullness can usually be felt in Scarpa's triangle over the head of the femur A positive Trendelenburg's sign is present Muscular wasting does not occur nor is the gluteal fold absent as happens in a tuberculous arthritis The X ray appearance varies according to the stage at which the condition is first seen. It differs markedly from that of a tuberculous arthritis in which there is an early decalcification of all the bones of the hip joint This does not occur in pseudo coxalgia In the early stages the epiphysis of the affected femur looks denser than that of the other side and is also flattened, making the joint line between the head of the femur and the acetabulum appear wider than normal (Fig 550) At a later stage the epiphysis is seen to be fragmented whilst the neck of the femur has become thickened Little difficulty should be experienced in making a correct diagnosis for the whole clinical picture is quite unlike that seen in a tuberculous arthritis.



Fig 550

X-ray appearance in an early stage of pseudocoxalgia. Note the increased density of the right femoral head and the commencing flattening

Treatment—If adequate treatment is instituted at an early date completely normal function should be obtained Rest in recumbency

with a fixed extension is essential No weight bearing of any kind must be permitted until the skiagram shows that the bones concerned have recovered their normal density Such treatment needs to be maintained for a period of twelve months or perhaps longer



FIG. 551

The late results of poor treatment in pseudo-coxalgia in the left hip. Note the great broadening of the neck of the femur and the bad re-formation of the head

Treated in this way a hip joint with a full range of movement in every direction is obtained, but if neglected an impairment of function results which in later years may be followed by an osteo-arthritis in consequence of a misshapen femoral head articulating with an acetabulum, into which it does not fit (Fig 551) Treatment in recumbency whilst changes are taking place in the upper end of the femur does not prevent the femoral neck from becoming thickened or the epiphysis from being flattened out to some extent It does however maintain a smooth articular surface fitting the acetabulum the upper lip of which grows out a little to accommodate the slightly enlarged head.

KOHLER S DISEASE

This is an osteochondritis affecting the tarsal scaphoid It commences most commonly in boys about the age of 4 or 5 years The onset is sudden, the child limping and complaining of pain in the foot The dorsum of the foot over the scaphoid becomes swollen, hot and tender symptoms which in many ways resemble those of a tuberculous osteitis of this bone An X ray shows the scaphoid to have a bony outline smaller than that of the other foot The nucleus is denser flattened and sometimes fragmented. It can be differentiated from a tuberculous osteitis by the fact that neither is there rarefaction of the bone nor any loss of density in the other bones of the tarsus (Fig 552)



FIG 552

X-ray appearance in Kohler disease.

Treatment —If the symptoms are very marked the foot requires fixing in plaster for a month otherwise all that is necessary is to keep the tarsus strapped until symptoms subside and an X ray shows that the bone has recovered its normal

SCHLATTER'S DISEASE

This condition is seen most often in boys at school and everything points to it being traumatic in origin The upper portion of the tibial tubercle is lifted up from the underlying shaft of the tibia by the *pull of* the ligamentum patellæ Pain swelling and tenderness are the clinical signs whilst the tubercle itself appears to be enlarged An X ray will show it lifted up from its base and at times also fragmented (Fig 553)

Treatment—If the tender area is strapped full activity except participation in strenuous games may be permitted In most patients



FIG. 553
X-ray appearance in Schlatter's disease

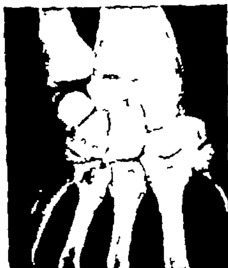


FIG 554
X-ray appearance in Keinboch's disease

the symptoms persist for about six weeks It is seldom necessary to fix the limb in plaster of Paris.

SCHEUERMANN'S DISEASE

This condition is an osteochondritis affecting the epiphyses of the vertebræ in young children. It is likely to produce later a kyphosis as the result of disturbed *development* of the vertebræ unless the child is treated in recumbency during the active stage Unfortunately many children have already developed a kyphos before advice is sought

KEINBOCH'S DISEASE

This is a condition somewhat similar to Kohler's disease which develops in the semilunar bone of the wrist It differs, however in that it occurs in the adult and not the child Injury appears to have a close relationship to its occurrence Pain and limitation of movement with muscular spasm and tenderness over the dorsum of the wrist are complained of The X ray shows flattening of the semilunar bone with areas of apparent increased density (Fig 554) in other words an aseptic necrosis of this bone Treatment consists in fixation in plaster

until the pain and tenderness subside Excision of the semilunar bone may be necessary to relieve symptoms but restoration of function after operation is very delayed and in the end an arthrodesis of the wrist joint may be necessary to free the patient from a severe disability

Osteochondritis has been and continues to be described in many bones but those given above are most commonly seen

HYPERTROPHIC PULMONARY OSTEO-ARTHROPATHY

This is a rare condition which may develop in patients suffering from any chronic pulmonary disease such as bronchiectasis though it is also seen in children with congenital cardiac disease or in adults with a chronic heart lesion The ends of the fingers become enlarged and swollen or clubbed, due to thickening of the soft tissues Later new bone formation takes place along the shafts of the phalanges. Patients who have suffered from pulmonary or cardiac disease for many years may exhibit similar changes in the bones of the forearm and leg The condition probably results from some toxic absorption, or is produced by an interference with the return of blood from the extremities which are in a condition of constant venous engorgement Treatment has little influence upon this condition.

CLEIDO-CRANIAL DYSOSTOSIS

This is a rare familial condition in which certain membrane bones fail to undergo proper ossification. Sometimes several members of one family are affected As the result of imperfect development of the frontal and parietal bones the anterior fontanelle may remain widely open until late adolescence This is not a hydrocephalic condition though at first sight it may appear to be so and the child is of normal mental development The clavicles also are only partially developed so that the shoulders can almost be made to touch in front of the thorax. This partial absence produces very little functional disability No treatment will hasten in any way the ossification of the bones concerned The portion of the clavicle which is undeveloped in the child remains so throughout life

TUMOURS OF BONE

Tumours of bone may be simple or malignant, the latter being either primary in the bone itself or secondary to some other neoplasm.

SIMPLE TUMOURS

Almost any type of connective tissue can give rise to a tumour in bone but in practice they are few in number chondromata osteomata and osteoclastomata being the only ones which are commonly met with

CHONDROMATA

A chondroma is a tumour composed of a lobulated mass of avascular hyaline cartilage the surface of which is covered with a layer of fibrous tissue forming a limiting membrane The cartilage which composes

it differs from the normal hyaline variety of articular cartilage in that its cells vary in size and shape and are arranged in an irregular manner. Two types of chondromata occur in bone

1 **Multiple Chondromata or Enchondromata** are seen in the small bones of the hands and feet although the latter are much less often affected than the former. The cartilaginous tumour begins in the interior of the shaft close to the epiphyseal cartilage and as it increases in size produces an expansion of the bone thus forming a fusiform swelling. After a time these swellings may reach a large size when they are lobulated and irregular in appearance (Fig 555). The growth of the tumour by its pressure produces an absorption of the osseous tissue surrounding it but while this is occurring new bone is laid down



Fig. 555
Multiple enchondromata in the finger

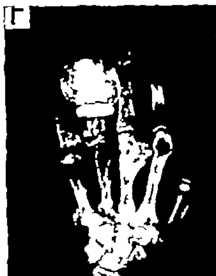


Fig. 556
X-ray appearance of multiple chondromata in the hand.

beneath the periosteum and in this way the bone appears to have been expanded by the *development* of the growth within. An X-ray at an early stage will show only a cyst of the bone together with destruction of the cancellous tissue and thinning of the cortical bone (Fig 556). These tumours *seldom give rise* to any symptoms *beyond deformity of the finger or if they* have been present for a long time advice is sought on account of interference with the function of the hand or for cosmetic reasons. Diagnosis when the tumours are of any size is easy but *when the first one appears it is very similar* to either a simple cyst or a tuberculous dactylitis. From the former it may be impossible to differentiate until it is explored whilst from the latter it can be distinguished by its slower period of development and the absence *of any tenderness* or inflammatory involvement of the skin, such as is usually seen in a dactylitis

2 **Solitary Chondromata.**—A solitary chondroma is found most commonly *at the upper end of the femur* or *humerus* or it may arise

Osteoclastoma

This benign giant-cell tumour develops most frequently at the lower end of the femur the upper end of the tibia or the lower end of radius although it can occur in almost any bone When it begins in the femur it starts as a central growth in one or other condyle and gradually destroys the cancellous tissue As the tumour enlarges it produces by expansion a thinning of the cortical bone Only very rarely does it invade the articular cartilage Its substance is reddish brown in colour and is a mixture of fibrous tissue blood spaces and cystic areas (Fig 561) The characteristic feature of the histology of



Fig 559

The lower end of the femur destroyed by an osteolytic sarcoma.



Fig. 560

X ray ppearance of an osteogenic sarcoma.

this tumour is the presence of multinucleated giant cells lying in an openwork stroma of cells with spindle-shaped nuclei These giant cells are derived from the osteoclasts and the tumour is therefore known as an osteoclastoma It develops generally in early middle life and the increase in size takes place at a moderate rate Owing to the absence of pain it has often developed to a considerable size before being recognised A sympathetic effusion into the *neighbouring* joint is sometimes present if the tumour is of any size and this may obscure its presence by directing attention to the joint rather than to the growth itself Pulsation may be elicited, but the so-called egg-shell crackling is rarely if ever obtained. A skiagram shows a cystic *expansion of the bone with coarse trabeculæ running in an irregular* manner across the diseased area Where the growth abuts on to normal bone an attempt at sclerosis is sometimes seen as though an effort was being made to isolate the tumour and prevent its expansion into the normal cancellous tissue



FIG. 561

The upper end of a tibia replaced by an osteoclastoma, the characteristics of which are well shown.

Treatment —There are two methods of treatment of these growths When recognised early they respond very well to treatment by the radium bomb ceasing to grow and the bone being restored to its normal texture In those which are too large for this treat ment under a tourniquet the tumour must be explored and the growth cleared out The walls of the cavity need to be curetted very carefully with a sharp spoon In some situations it will be advisable to excise completely the portion of bone involved and to replace it with a bone graft If the tumour has destroyed an extensive area of bone or the soft tissues are already involved an amputation of the limb will be necessary as the only means of obtaining a complete cure



Fig 562
A clavicle showing enormous growth of new bone in an osteogenic sarcoma.

MALIGNANT DISEASE OF BONE

Osteogenic Sarcoma

This type of tumour is comparatively rare although it is the most common malignant tumour to commence as a primary growth of bone It has long been customary to consider two types of sarcoma of bone the periosteal and the endosteal This is a purely artificial classification The growth may spread more towards the interior (Fig 559) in one case the so-called osteolytic type, whilst in another it may spread beneath the periosteum producing what is re garded as the typical periosteal sarcoma with spicules of bone set at right angles to the shaft (Figs. 562 and 563) thus giving the characteristic fan like or radiating appearance in a skiagram (Fig 560) What influences the direction of spread of the growth is unknown. It needs to be appreciated that in only about 18 per cent of bone sarcomata is this radiating appearance seen and that therefore it is not a characteristic of the majority of these tumours The growth is limited by the periosteum so long as this membrane remains intact but once it is destroyed by the growth or opened by an exploratory

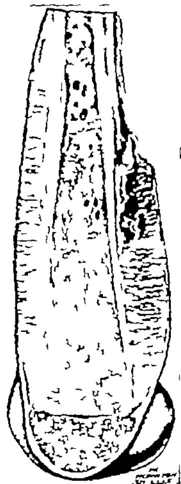


Fig. 563
An osteogenic sarcoma of the lower end of the femur with the typical radiating spicules of bone

been ruled out Few primary osteogenic sarcomata have ever been described apart from osteitis deformans in a patient of this age

If there is any doubt as to the nature of a tumour which is suspected of being a sarcoma exploration for the purpose of making a histological examination *should be avoided* In many cases the biopsy has failed to make the diagnosis certain, whilst an exploration increases the rapidity with which secondary deposits may occur for incision of the periosteum removes the only restraining force An osteogenic sarcoma seldom perforates the skin save through an area of scar tissue Instead of exploring the tumour it should be subjected to treatment with X rays when if it is an osteogenic sarcoma, ossification will commence almost at once in the tumour substance and the diagnosis settled

The *prognosis* of an osteogenic sarcoma is bad Nearly every patient with such a growth, by whatever method it has been treated or however early the correct diagnosis has been made is dead within three years In every case secondary deposits ultimately develop in the lungs and occasionally elsewhere (Fig 568) Sometimes they appear within a few weeks of the primary growth being discovered and at other times not for two years No indication can be given as to the length of time which will elapse between the discovery of the primary growth and the appearance of secondary deposits



FIG 568 Widespread cutaneous metastasis from a sarcoma of the ilium.

Treatment —In view of the almost certain knowledge that amputation of the limb does not save the patient from secondary deposits there is a tendency at the present day to avoid this method of treatment and to employ either radium or deep X ray therapy both of which will stop the growth for a time An X-ray taken subsequently will show a considerable amount of ossification in its substance Unfortunately the influence of these therapeutic measures does not appear to have a lasting effect, and sooner or later the tumour begins again to increase in size Amputation then becomes a necessity for the relief of persistent pain Disarticulation through the hip joint in cases of sarcoma of the lower end of the femur or of the tibia is an unnecessarily mutilating operation for the result is no better than an amputation through the middle of the thigh which enables a good artificial limb to be fitted. Rarely if ever does the growth recur in the amputation stump itself

Ewing's Sarcoma

This growth is a very rare tumour which starts in the middle of the shaft of a long bone (Fig 569) The clinical signs are similar to those of a subacute or chronic osteomyelitis there being attacks of pain and tenderness with rises of temperature which settle *down for*

an interval only to recur again perhaps several weeks afterwards The shaft of the affected bone is felt to be thickened and tender A skiagram shows changes very similar to those seen in a chronic osteomyelitis except that the subperiosteal bone which is laid down, is arranged parallel to the shaft in definite layers like the layers of an onion whilst the surface of the bone is smooth and not rough as it is in a chronic infective osteitis The cells of the tumour are small and round being arranged in intimate relation to the blood vessels There are no giant cells in these tumours



Fig. 569

The middle of the shaft of the femur showing a Ewing's sarcoma.

The *diagnosis* is very difficult for exploration is dangerous as the tumour is liable to become more vigorous in growth afterwards and subsequently to fungate through the incision.

Treatment —Radium or X ray therapy will produce a diminution in the size of the tumour and relief of symptoms so that it appears to be cured, but after a few months the attacks recur Secondary deposits eventually occur although amputation is considered to give a better prognosis provided it is performed early than it does in an osteogenic sarcoma

Multiple Myeloma

Myelomatosis is a rare disease in which multiple growths develop in the marrow with destruction of both the cancellous and cortical bone there being no attempt at the formation of new bone This condition is seen most commonly in patients of 40 to 60 years of age and is associated with poor general health It is now believed to be a plasma-celled sarcoma The most constant symptom is bone pain of a persistent nature Bence-Jones's protein is found in the urine in only 50 per cent of cases and its absence is of little importance in making a diagnosis Its presence in the blood is quite frequent The condition as seen in skiagrams may resemble very closely that of multiple secondary growths Treatment is of little value but the intense pain may for a time be relieved by X ray therapy

Secondary Malignant Disease of Bone

Malignant disease of bone secondary to some other growth is most commonly seen in association with a carcinoma of the breast (Fig 570) but tumours of the prostate and thyroid often give rise to osseous metastases, as also do hypernephromata of the kidneys.

The clinical signs of secondary deposits in bone fall into two main groups In one class the presence of the deposit is revealed by pain developing for no obvious reason The characteristic feature of this pain is that it slowly but steadily increases in severity and duration

until it becomes constant both by day and night, so that relief is obtained only by the administration of constantly increasing doses of drugs The second class is that in which the presence of a carcinomatous deposit in bone is unsuspected until a pathological fracture takes place



Fig 570
Extensive replacement of the humerus by secondary carcinoma.

The characteristic X ray feature of secondary deposits is absorption of bone by the growth and absence of new bone formation (Figs 571 and 572) in most, but occasionally osteosclerosis is well marked (Fig 573)

Secondary carcinomatous deposits are found more commonly in certain situations than others Thus metastases from a tumour of the breast are seen most often in the body of a vertebra, where they give rise to persistent pain and the development due to destruction and consequent collapse of the vertebra, of a sharp kyphosis which is not unlike that seen in a tuberculous spine They are also not uncommonly found in the femur below the trochanters and this is a common situation for pathological fracture Secondary deposits from a tumour in the thyroid or from a hypernephroma often occur without evidence of the primary growth. The secondary growths from a hypernephroma develop most frequently either in the intertrochanteric region of the femur or in one of the bones of the pelvis They are very difficult to distinguish from other malignant growths especially as they may pulsate in the same way as does an osteogenic sarcoma, but they occur in older subjects than do primary growths



Fig 571
Secondary deposits in the twelfth dorsal vertebra.

Treatment —The treatment of a secondary malignant growth of bone is entirely confined to providing relief of symptoms. Usually this means the administration of such drugs as are necessary X ray therapy or the radium bomb sometimes appears to relieve pain but the general disturbance to the

patient's health often excludes its employment. Pathological fractures require splinting in the same way as any other fracture and in many instances union does take place. Fractures due to the presence of a secondary growth from a hypernephroma do not unite and the patient rapidly becomes gravely ill.



Fig. 572

Secondary carcinoma in the upper end of the femur



Fig. 573

Secondary involvement of both femur and pelvic girdle from carcinoma of prostate showing marked sclerosis.

CYSTS OF BONE

Simple cysts of bone are uncommon, but are seen in the neck of the femur, the upper end of the humerus and the tibia. They give rise to few symptoms and their presence is often unsuspected until a pathological fracture occurs. X-ray examination reveals the presence of a cyst with absorption of the cortical bone through which the fracture has taken place. Exploration of such a cyst reveals a cavity filled with a clear yellow fluid and lined with a thin membrane which often contains giant cells. These cysts are probably a localised osteitis fibrosa and are seen in children or adolescents (cf. Fig. 545, p. 1089).

Treatment.—When a fracture takes place through such a cyst union often occurs and the underlying bone lesion is in most *instances thereby cured. If the cyst is discovered before fracture it* should be explored and curetted out, whilst the introduction of a graft to fill up the gap left will at times hasten recovery and obliteration of the cyst.

Hydatid Cysts.—The presence of hydatid cysts in bone is rarely seen in this country except in patients who have lived in climates where the *Tænia echinococcus* is met with frequently. In consequence the diagnosis is seldom made correctly. The cysts produce destruction

of the cancellous tissue and then absorption of the cortical bone Symptoms are rare and the occurrence of a pathological fracture is usually necessary to call attention to disease of the bone

Treatment—Exploration of the affected bone and curettage are required, and after this the disease seldom recurs When the bone has been fractured the cysts first require removal when if the bone is adequately splinted union readily occurs

E I BROCKMAN

CHAPTER XLVIII

DISEASES OF JOINTS

GENERAL CONSIDERATIONS.—Before considering the diseases which affect the joints of the body it is necessary to review briefly certain anatomical points, for upon a proper knowledge of these depends the appreciation of the pathological changes which occur in them. Every joint is a potential space between the ends of the bones which form the articulation Their surfaces are covered with a layer of hyaline cartilage, which is called the articular cartilage It is avascular and derives its nutrition from the synovial membrane and from the underlying bone. As long as this articular cartilage remains intact it is very resistant to infection, but once any portion of it has been destroyed the remainder is rapidly undermined by the inflammatory process and, a portion having been separated from the bone, it quickly peels off in pieces which disintegrate and disappear Connecting the two ends of the bones with each other is the capsule, which is strengthened by various ligaments to resist the many strains to which the joint is exposed. The movements of a joint are brought about by muscular action, and if the muscular control of a joint ceases for any reason the capsule and ligaments rapidly stretch The inner surface of this capsule is lined by synovia a serous membrane secreting a clear glairy fluid which is normally sufficient only to lubricate the opposing surfaces The synovial membrane reaches to the edge of the articular cartilage but does not cover its surface In those joints in which there are intra-articular ligaments, such as the knee these are also covered with a layer of synovia. In joints where spaces exist between the synovial membrane and the capsule, such spaces are filled with fatty tissue which permits an alteration in the normal capacity of the joint to occur In many instances pouches of synovial membrane protrude from the joint cavity between the muscles controlling its movements, and these are liable to become involved and distended in inflammatory conditions of the joint itself. The inner surface of the synovial membrane is covered with a number of small villi, which are not visible to the naked eye under normal circumstances, but which in chronic inflammation of a joint become enlarged and hypertrophied, giving the synovial membrane a shaggy appearance known as a *villous arthritis* The blood supply of the synovial membrane is derived from the circulus vasculosus which is formed around the joint from the many articular vessels which are present

In certain joints *e.g.*, the hip knee, elbow and shoulder the epiphyseal cartilage lies partly within the joint cavity and an osteitis or inflammation of the metaphysis is thus more likely in these situations to infect the joint

The nerve supply of a joint is derived from the nerves which supply the muscles controlling its movements, and therefore two joints may receive branches from the same nerve in which case disease of one joint may cause pain to be referred to the other Movements are controlled by the muscles which arise from or are inserted into the bones forming the joint, and when

ever inflammation occurs either as the result of trauma or infection the muscles controlling its movement go into an involuntary spasm to prevent this taking place Such spasm is protective and entirely independent of the will of the patient But not only do these muscles go into this protective spasm, but they also start rapidly to waste Thus, in the case of disease of the knee joint the vastus internus may waste to an appreciable extent within a few days.

Methods of Examination—In all diseases of joints the taking of an accurate and detailed history is essential and in particular the details of how the condition first commenced are all important Only when this history has been obtained can examination profitably be carried out In all patients the corresponding joint on the other side of the body must be exposed so that the normal may be used for comparison otherwise there is no standard by which to judge the affected joint.

Inspection reveals the presence of any deformity of swelling or redness and of wasting of the muscles which control the movements of the joint.

Palpation will demonstrate any tenderness, increase of local temperature and the presence or absence of an excess of synovial fluid in the joint cavity The position where tenderness is found must be accurately defined whether it is over the reflections of the synovial membrane the edges of the articular cartilage the capsule the attachment of ligaments, or on the bone-ends themselves The examination of the range of movement requires great attention. It is first necessary to ascertain whether limitation of movement if any is due solely to an involuntary protective muscular spasm or to any other cause. Very great care should be taken to identify minor degrees of limitation of movement in each direction, for these are the early signs of disease and for this reason examination of the corresponding sound joint is all-important for only by a comparison of the two can these minor limitations in movement be appreciated. The protective muscle spasm, in addition to preventing any movement taking place during the acute disease may at the same time produce certain fixed deformities if it is permitted to act uncontrolled for any length of time Thus in disease of the hip in the early stages this joint may be fixed in a position of flexion, abduction and external rotation In the later stages the fixed deformity which is present, is the result of changes which have taken place in the joint during the progress of the disease and also of secondary contractures which have occurred in the muscles, ligaments and joint capsule

In the early stages the presence of a protective muscular spasm can be demonstrated by making a short sharp movement, when the muscles can be both seen and felt to contract. This protective muscular spasm can be very well demonstrated by forced internal rotation in an early example of disease of the hip joint.

Measurements of joints are of little value with certain exceptions. Any swelling or muscular wasting should be estimated by inspection and palpation the degree of either being judged by a comparison with the sound joint In the hip measurements are of value in that they reveal the presence of any change in the relationship of the head and neck of the femur to the acetabulum. Damage or destruction of any of the components of the hip joint results in a raising of the great trochanter which can be revealed by measurements. Two particular methods are employed in the examination of all lesions of the hip joint In one a line is drawn from the anterior superior spine of the ilium to the most prominent part of the tuberosity of the ischium This, known as *Nélaton's line* normally passes through the tip of the great trochanter When any alteration in the relationship of the head and neck

of the femur to the acetabulum has occurred the great trochanter is raised above this line The same information can be obtained by the measurement known as *Bryant's triangle*, which is formed by dropping a perpendicular line from the anterior superior spine on to the couch on which the patient is lying a second line is drawn from the anterior superior spine of the ilium to the tip of the great trochanter the triangle being completed by a third line which passes from the tip of the trochanter at right angles to the first line A comparison of the two triangles on either side will reveal whether the trochanter is raised or not, and to what extent. Whilst Bryant's triangle is, strictly speaking, a more exact measurement than is Nélaton's line the latter for all pratical purposes is accurate enough and at the same time is more convenient to employ Lastly the stability of all joints requires examination, especially in the knee and hip In the latter this can be revealed by the presence or absence of *Trendelenburg's sign*. When the patient is made to stand on a sound leg with the knee on the other side flexed to a right angle the buttock on the latter side is raised to a higher level than that of the limb upon which the patient is standing When the hip joint has been damaged by any disease standing on the affected limb will result in the buttock of the sound side falling to a lower level. This sign is present in any condition in which there has been an upset of the normal mechanics of the hip joint *e.g.*, pseudocoxalgia, an old tuberculous or infective arthritis not followed by ankylosis, coxa vara and *congenital dislocation*.

X-ray examination of all joints suspected of being the site of disease is essential, and to be of any value must include for comparison a skiagram of the sound joint on the other side Both hips should be taken on the same film as only thereby can a true comparison be made

INFLAMMATION OF JOINTS

When any inflammation develops in a joint the changes which occur are identical with those produced in any other structure being modified solely by the structure of the joint The synovial membrane lining the joint capsule under normal conditions secretes a minute quantity of fluid which helps to nourish the articular cartilage and provides a lubricant for the joint surfaces As the result of injury or disease the amount of fluid secreted is increased and an *effusion* is said to have taken place This increased secretion of fluid is part of the response of synovial membrane to inflammation known as *synovitis* In this respect the synovial membrane is identical with the peritoneum and pleura, both of which when inflamed secrete an excess of fluid As a result of this effusion the joint outlines are altered in appearance being more easily appreciated in some joints than others depending upon the amount of muscular tissue which surrounds them The type of effusion varies according to the cause of the inflammation. Thus it is called a *serous* effusion if only of lymph and serum, whilst if this becomes infected with organisms and contains leucocytes it is known as a *purulent* effusion and an *empyema* is said to be present when the joint is distended with such fluid. A blood-st[illegible] effusion is known as a *haemar[illegible]*
throsis and occurs in injuries whic[illegible] r the synovial membrane or ligaments, or else the [illegible] g into the *formation* of the joint surfaces. [illegible] rosis ma[illegible] n in hæmophilia scurvy and certain blood d[illegible] tion int[illegible] nt which is surrounded by strong muscles, [illegible] ult to i[illegible] the co[illegible] ion of fluid is

large in amount On the other hand in the *knee* which is not surrounded by large muscles an effusion is readily identified as it causes disappearance of the normal hollows on either side of the patella and ligamentum patellæ whilst the subcrureal pouch becomes distended and obvious When the effusion is considerable in amount no difficulty will be experienced in identifying its presence but when there is only a slight effusion it can be recognised by means of a "patellar tap This consists in pressing the patella backwards with a sharp movement when it can be made to knock up against the articular surface of the anterior aspect of the femur the tap displacing any fluid which lies between the two bones If only a little fluid is present it can be identified by the same method when pressure is exerted on the subcrureal pouch so as to force any effusion, which may have collected here into the lower part of the joint

When an effusion is present in the *ankle joint* the limb is held by *muscular spasm in* a position of equinus or equinovarus. The anterior aspect of the joint is distended and the hollows which normally exist on either side of the tendo achillis are obliterated

At the *shoulder* the joint appears more rounded and its anterior aspect is filled up so that the hollow below the clavicle disappears. When effusion in this joint is excessive it may track down the bicipital groove along the prolongation of the synovial membrane accompanying the tendon of the biceps thus causing the appearance of a swelling in the upper arm.

At the *elbow joint* the grooves on either side of the tendon of the triceps are filled up and the prominence of the olecranon disappears.

At the *wrist joint* swelling appears all round the joint, being more marked on the dorsum and laterally The hand is held in flexion and the condition can be distinguished from a tenosynovitis by the fact that with an effusion of the joint the tendons can move freely whilst the characteristic fine crepitus of a tenosynovitis is absent.

When inflammation spreads from the synovial membrane to the other structures of the joint, the condition is known as *an arthritis* Such an inflammatory process may be caused by a variety of infections being either acute or chronic in nature As the result of any type of arthritis the articular cartilage is liable to become softened and eroded. The bones may become the site of an osteitis and the capsule and ligaments be damaged or destroyed. In the process of healing the damaged structures are replaced by fibrous tissue which forms adhesions between the various parts of the joint Should the joint be very badly damaged the bone surfaces may be completely exposed and become fused together with osseous tissue An *ankylosis* is said to have taken place When movement is prevented by the formation of fibrous tissue a fibrous ankylosis is said to have occurred Such an ankylosis is unsound there always being present a little movement which if forced, is likely to give rise to pain and swelling Deformities often develop in this type of ankylosis owing to the stretching of fibrous tissue from the pull of the more powerful muscles When all movement has been abolished by osseous union between the two ends of the bones a bony ankylosis is said to have taken place In some cases of disease of the joint it is possible to retain movement whilst the inflammation is subsiding but in other conditions, such as tuberculous arthritis, ankylosis is nature s method of attempting to cure the disease and movement must be prevented by fixation either with some form of external splint or by operation, which aims at removing all the damaged tissue so as to leave two bony surfaces that will fuse together

Ankylosis —The position in which a diseased joint should be maintained if there is any danger of it becoming fixed varies with each individual joint

for should it become fixed, it must do so in the position in which it will ultimately serve the most useful function ("the position of election")

In the hip the deformity of adduction and internal rotation must be avoided and the joint held in slight abduction Flexion to 30 degrees is desirable to enable the patient to sit down in comfort.

The knee needs to be fixed with a few degrees of flexion, as full extension of the joint makes it hard to clear the ground with the foot, whilst any marked degree of flexion gives an ugly gait in walking due to the apparent shortening Fixation of the ankle must be obtained at a right angle.

In the case of the shoulder an ankylosis is a considerable disability owing to the inability to rotate the limb in any direction It should be held in about 45 degrees of abduction and slightly in front of the coronal plane of the body Movements of the arm with the shoulder fixed in this position may be quite good owing to the movement between the thorax and the scapula Too wide abduction is a disability as it prevents the arm being placed in contact with the side of the trunk. Loss of movement at the elbow is serious and the position in which ankylosis should be allowed to take place must depend upon the work of the patient For most purposes the forearm supinated and flexed to 90 degrees was said to be the position of choice but such a position is really of little or no value The forearm should be pronated and the degree of flexion or extension be decided upon in each individual

The wrist must always be held in moderate extension, for ankylosis in flexion completely destroys the power of the hand.

The type of ankylosis, which follows upon an arthritis, depends upon the organism which is responsible for the infection and also upon the severity of the arthritis. Thus a tuberculous arthritis uncomplicated by any secondary pyogenic infection results in a fibrous ankylosis, whilst an acute pyogenic infection which destroys the cartilage of the joint produces a true bony ankylosis. If an arthritis is treated in the proper position, it should be possible to prevent the development of deformities, which would later interfere with the patient's activities.

Operations upon Joints—**Arthrotomy** consists in opening the joint cavity to examine the interior or to remove a portion of the synovial membrane for histological examination. This operation is also performed to remove a loose body or a torn cartilage or to let out the purulent fluid in a septic arthritis.

Synovectomy signifies the complete removal of the whole of the synovial membrane of the joint, and is sometimes carried out in the knee joint in patients with a villous arthritis, when the articular cartilage is not involved to any appreciable extent

Arthrodesis, or fixation of a joint entails the removal of all the synovial membrane and any intra-articular ligaments as well as the cartilage from the bones forming the joint, with the object of allowing the two raw surfaces of bone to come into close apposition so that osseous union may take place between them and thus movement of any kind be permanently abolished.

After this operation the limb needs to be fixed in plaster until fusion has occurred, but in a few weeks the patient must be encouraged in the case of the lower limb, to walk on the limb in this plaster as weight-bearing is the best stimulus to encourage a satisfactory bony fusion. The period of time which is necessary before a bony ankylosis occurs depends upon the form of arthritis.

Excision of a joint is similar to an arthrodesis except that the ends of the bone are widely removed by means of a saw instead of the cartilage being simply removed with a gouge

Extra-articular Arthrodesis is fixation by means of a graft passing between the two bones concerned without removal of the two surfaces of the joint.

It is most commonly employed in dealing with the hip joint but though called extra-articular it is not truly so as the joint in most instances must be opened in order to enable the graft to be satisfactorily fixed in position

TRAUMATIC SYNOVITIS

This condition occurs as the result of any injury to a joint either with or without a fracture In the former the effusion is generally only serous but if a fracture involves the joint surfaces the fluid may contain a variable amount of blood The effusion develops rapidly and the joint becomes painful tender and hot

It is held fixed in a position of flexion by muscular spasm and any attempt at movement gives rise to pain. The synovial membrane is bruised or torn and becomes inflamed. Unassociated with any other injury a traumatic synovitis should respond well to treatment the objects of which are to allow the injury of the synovial membrane to recover and to promote absorption of fluid as soon as possible whilst at the same time guarding against muscular wasting and the formation of adhesions which later would interfere with the function of the joint.

Treatment —In the first few days rest is essential to permit healing of the synovial membrane promote absorption of fluid and relieve pain. There is a danger of resting the joint for too long a period therefore it is wise not to use any kind of splint Where possible the joint should be fixed with a pressure pad and bandage which in addition to providing some fixation also by the exercise of pressure promotes the absorption of the fluid within the joint cavity At the same time the muscles controlling the joint must be kept in condition otherwise if they are permitted to lose their tone and waste recovery may take a long time and the function of the joint subsequently be badly impaired.

It is only necessary to encourage the patient to use the joint through as great a range as possible provided this does not excite muscle spasm or cause pain. Passive movements definitely do harm for they are out of the control of the patient and massage to the joint itself will often delay recovery rather than hasten it Any massage which may be given must consist simply in stroking the limb to soothe the spasm which may be present.

Should active movement not be maintained in an acute traumatic synovitis the surfaces of the synovial membrane where they are in contact with one another are liable to become stuck together by the formation of fibrous bands and adhesions of varying thickness and strength. However well a traumatic synovitis is treated these adhesions do occasionally form. They may be quite slender but nevertheless interfere with movement and hence cause a loss of function. Even minor limitations of movement may produce an interference with function quite out of proportion to the loss of range The only treatment for such a condition is a manipulation of the joint under anæsthesia If movement is only slightly restricted such a manipulation can at times be carried out without any anæsthetic if the patient can be persuaded to relax the limb completely The manœuvre in these patients consists in moving the joint once through its full range in each direction. Great force is not required to do this with complete

satisfaction The joint having been moved, the patient must subsequently be made to use it actively Little if any reaction follows and the condition is usually cured in a dramatic manner If movement is very limited, with adhesions of long standing it is wiser to move the joint through a limited range and observe how much reaction takes place If this is considerable further manipulation must be postponed until it has subsided, whilst if there is none the joint can be put through its full range on the second occasion without further delay or risk.

PYOGENIC INFECTIONS OF JOINTS

The infection of joints by pyogenic organisms in most instances occurs as the result of a blood borne infection from some other focus but occasionally it may be a direct infection from a perforating wound though this is rare in civil life Direct extension from a bone, the site of an osteitis will produce an arthritis or the joint may be infected by a pyæmic embolus The organism responsible is usually a staphylococcus or streptococcus other infections being comparatively rare

Whilst in theory an acute infective synovitis is possible, in actual practice any infection of this nature involves the whole joint to some extent although its principal effect may be synovial

Whatever the source of the infection the onset is usually sudden The joint becomes distended with fluid is very painful, hot and tender It is held in a position of flexion by involuntary muscle spasm and any attempts to move it give rise to great pain and are resisted by the patient who is obviously in real distress and quickly begins to show signs of toxæmia and fever and may even in quite an early stage have one or more rigors If the condition is not treated, or in spite of treatment continues to progress the general state of the patient rapidly deteriorates He refuses food and becomes more toxic the temperature and pulse continuing to rise still further The skin over the joint becomes red and the surrounding tissues œdematous pus may burst out of the capsule and invade the overlying muscles whilst, as a result of the inflammatory changes the capsule and ligaments may soften or be destroyed and a *pathological dislocation* of the joint take place

Unless satisfactory treatment is instituted at an early stage of the disease the patient will die either of septicæmia or toxæmia, or will be left with a badly disorganised joint with multiple discharging sinuses and a chronic osteitis, which may lead ultimately to the development of lardaceous disease

Pathology —When acute pyogenic infection occurs the synovial membrane rapidly becomes red, swollen and congested From this inflamed membrane there is exuded a large quantity of fluid containing a few pus cells and organisms If the joint is aspirated at this stage the fluid drawn off may appear quite clear and slightly yellow but microscopical examination after it has been centrifuged and cultivated will reveal its true contents This fluid, however rapidly becomes purulent from the addition of polymorphonuclear leucocytes which have migrated thence from the blood vessels of the synovial membrane, and the condition is now known as an *empyema* of the joint If successful

treatment is instituted at this stage permanent damage to the joint may be avoided Otherwise the synovia is converted into granulation tissue and this spreads very rapidly as a *pannus* on to the edge of the articular cartilage which becomes softened and speedily eroded both at the margins and more especially at those spots where pressure is exerted It will be stripped up from the underlying bone granulation tissue having spread beneath it and may lie loose in the joint in flakes which are rapidly absorbed The ligaments and capsule of the joint are œdematous and softened allowing subluxation or even complete dislocation to take place The bone beneath the cartilage becomes the site of an acute osteitis with absorption and necrosis of the cancellous tissue which is converted into a mass of granulation tissue exuding quantities of pus (Fig 574)



FIG 574

An acute pyogenic arthritis of the knee. The joint has been opened from the front, the patella being turned back. The articular cartilages are seen to be eroded by a "pannus" of granulation tissue.

Treatment —As in acute osteomyelitis so in acute infective arthritis of joints the use of penicillin has completely changed the outlook.

Treatment has three aims—first to kill the infective organism with penicillin and this must be given in sufficiently large doses secondly to relieve the tension within the joint and thirdly to fix the limb in an appropriate splint with extension until the disease has subsided. A fixed extension rather than a weight and pulley is desirable The object of fixation and extension is to keep the inflamed joint at rest by maintaining surfaces a little distance apart thereby avoiding as far as possible any damage to the softened articular cartilage and at the same time relieving the patient of the acute pain, which is so exhausting In the early stages when the condition has only just started the tension within the joint can be relieved by aspiration which may be repeated if necessary but once the effusion has become frankly purulent the joint requires opening to permit free drainage Rubber drainage tubes are unnecessary If the capsule is freely incised nothing else need be done The introduction of drainage tubes within the joint itself is certain to lead to ankylosis subsequently and if they are employed at all they must be put down only to the capsule and not into it When the condition is very acute irrigation may be called for but it is not desirable as a routine With such treatment a certain number of joints will recover with a useful range of movement though it may be many

weeks before the inflammatory condition completely subsides, and it is impossible to give a prognosis as to the final result when the patient first comes under treatment.

When the articular cartilage has been destroyed and an osteitis of the underlying bone has started, fixation will need to be maintained in the position of election until ankylosis has occurred otherwise deformities will develop Any sequestra which may form during this stage require removal before the sinuses will heal completely Should the general condition, in spite of adequate drainage continue to get worse an amputation may be needed as a life-saving measure During the whole time the patient should be given an easily digested diet, the bowels being kept well opened and large quantities of fluid drunk. It is all-important to emphasise the need of sleep for otherwise a patient's resistance may break down simply from lack of rest, and appropriate measures must be taken at an early stage to attain this end.

Prognosis—This is always serious both as regards life, for the patient may die of septicæmia or pyæmia and also as regards the final function of the joint ankylosis resulting in the majority of patients

ACUTE ARTHRITIS OF SPECIAL JOINTS

The Knee Joint

Acute pyogenic arthritis of the knee joint is rare in civil life and when it occurs is generally the result of a perforating wound. It may become infected by direct spread from an osteitis of the lower end of the femur or the upper end of the tibia or in children from septic lesions on the skin in the neighbourhood or from a blood borne infection. The effusion is always marked and the limb is held flexed and lying on its outer side The joint is swollen whilst pain is very severe and the patient, usually a child will cry out if any attempt is made to move it A high temperature results and rigors may occur If left the skin very rapidly becomes hot and red.

Treatment—An acute arthritis of the knee joint resulting from a perforating wound should have been guarded against by a preventive course of penicillin. Once such an arthritis has developed the joint must be aspirated and a full course of penicillin instituted. At the same time the limb must be adequately splinted and remain so until all signs of inflammation have entirely subsided. If there is an osteitis in either the femur or the tibia which is recognised early it is possible that the effusion into the knee joint is a sympathetic one at first and the bone lesion must be opened to relieve the tension in the bone and provide free drainage If taken in time it is possible that the knee joint may be saved from infection and that the effusion will be reabsorbed. Once the effusion is infected the joint must be aspirated with all aseptic precautions in addition to draining the bone abscess This is done by introducing a needle into the joint on the outer side of the patella The knee is then fixed with extension in a Thomas's splint Aspiration may need to be repeated and if the local or general symptoms do not subside the joint must be opened on either side of the patella washed out and left open to provide free drainage the limb being fixed as before.

When free drainage with fixation has been provided the temperature falls to a lower level very rapidly in most instances

However well the condition responds to treatment many acute pyogenic infections of this joint result in a fixed knee after many months of illness but such a result should in the future be a rarity

The Hip Joint

Acute pyogenic arthritis of this joint is seen generally in young children as the result of an acute osteitis of the epiphysis of the head or neck of the femur rarely is it seen in older children or adults The onset is sudden, with acute pain and fever the limb being held everted and fixed in flexion and abduction by muscle spasm There is a rise of temperature with the usual constitutional signs In the early cases it is difficult to decide whether the condition is an arthritis or a pure osteitis, for there is no fullness over the joint, abscess formation cannot be detected and an X ray in this stage will not assist in the diagnosis If nothing is done the temperature continues to rise and the child becomes obviously more ill Left to itself the abscess will burst through the capsule and point either anterior to the great trochanter or through the posterior portion of the capsule when it collects in the buttock the head of the femur may dislocate backwards on to the dorsum ilii in consequence of softening of the capsule and destruction of a portion of the epiphysis or lip of the acetabulum

Treatment—As soon as it is certain that the joint has been infected a course of penicillin should be instituted, the joint opened and the tension relieved. The anterior approach is the most suitable if the joint needs opening unless an abscess has formed posteriorly when this must be opened as well. Fixation of the patient upon an abduction frame with an extension is necessary Fixation, besides keeping the inflamed joint at rest will prevent dislocation. Once the joint has been opened and tension relieved the general condition will improve

In infants the epiphysis of the head of the femur is usually damaged to some extent and may be entirely destroyed whilst the acetabulum always undergoes a certain amount of alteration. When all sepsis has subsided the joint is often partly subluxated and the patient walks with a limp though movement is surprisingly good. In older children or adults the final result is a bony ankylosis and therefore the hip joint must be kept during the active disease in a good position to prevent deformity Should sequestra form these will subsequently need removal. If the hip has become ankylosed in a bad position function can be much improved by an osteotomy below the trochanters the limb being fixed subsequently in plaster in a good position

Acute infective arthritis of other joints is rare and needs no special description the same principles of treatment being applicable

Pyæmic Arthritis

This type of arthritis results from a septic embolus and is seen generally with an osteomyelitis It is characterised by the joint becoming very rapidly distended with purulent effusion often without

flex or extend the forearm In the polyarticular variety of the disease the joints of the hands and feet are especially liable to become fixed, as are those of the spine in young adults where infection around the intervertebral joints and discs may produce a completely rigid spine.

Diagnosis—In the presence of a urethral discharge little difficulty arises in making a correct diagnosis. The fact that the patient denies any history of urethritis is of no importance and with a typical history of onset, the urogenital tract must always be examined The polyarticular form of arthritis may be confused with a rheumatoid arthritis which it much resembles though this latter condition starts more insidiously and symptoms may affect first one joint and then another

The prognosis of a gonococcal arthritis is uncertain as regards the ultimate function of the affected joint In the polyarticular form a considerable degree of permanent stiffness results especially when the joints of the spine are involved. The polyarticular variety is sometimes only one sign of a general systemic infection with gonococci.

Treatment—Immediate treatment of the urethral infection must be *instituted if this has not already commenced. With rest in bed*, adequate treatment of the original site of infection and chemotherapy the acute pain in the joint begins to subside Local treatment except by splintage to keep the joint at rest and prevent deformities has little effect. As soon as the acute pain has subsided the joint is treated with short wave therapy and every effort made to encourage active movement for only thereby can function be preserved A fibrous ankylosis unfortunately is only too common a sequela of gonococcal arthritis

Should suppuration occur bony ankylosis will result. Any attempts at forcible manipulation to obtain movement after the condition has settled down are to be discouraged for they are likely to be followed by a recurrence of swelling and pain, the joint becoming more stiff than before. Treatment by autogenous vaccines is sometimes of assistance in gonococcal arthritis but their value is difficult to assess.

TUBERCULOUS DISEASE OF JOINTS

The infection of a joint by the tubercle bacillus whilst not so common as it was fifty years ago is still sufficiently frequent to require very serious attention Like all other tuberculous lesions it is only one manifestation of a general disease It is essentially a disease of the young being especially common before the age of five years but it may develop throughout the period of adolescence In the adult tuberculous arthritis is very much more common than is usually thought Both sexes are about equally affected, and, whilst it is not hereditary some individuals are certainly more susceptible to infection than others Bad hygienic conditions may contribute to a lowering of the general resistance of the patient and hence this disease is more common in the less well to-do members of the population. Whilst injury is not a direct cause trauma may temporarily lower the resistance of the injured part and provide suitable conditions for the bacillus to develop and multiply

Pathology—The tubercle bacillus which has been lying in the mesenteric or thoracic lymphatic glands passes by the blood stream to the

joint having gained entrance originally via the alimentary canal or tonsils Children with tuberculous disease of a joint have evidence of pulmonary disease much more often than used to be thought if their lungs are X rayed as a routine A tuberculous arthritis may commence either in —

1 **The Synovia.**—When infection occurs in this membrane it has usually been present for some time before symptoms commence The synovia becomes congested, thickened and œdematous Tubercles are scattered over it just *below* the serous membrane through which they show as small white spots Some of these fuse together after a short time undergo caseation and ulcerating through the serous membrane leave small ulcers which permit the underlying disease to communicate directly with the joint cavity

2 **The Bone.**—*Infection may enter the joint from a pre-existing* tuberculous focus in one of the bones either in the epiphysis or in the metaphysis close to the epiphyseal cartilage (Fig 576) By whichever route the joint is attacked the prognosis is the same

Once the joint has been infected the synovial membrane becomes very much thickened and tiny tuberculous ulcers can be seen scattered over its surface Granulation tissue forms in it and thus begins to invade the other structures of the joint It slowly spreads on to the articular cartilage which it first softens and then erodes Once this has occurred at any one place the tuberculous granulation tissue very rapidly spreads beneath the cartilage and lifting it up separates it from the underlying bone A well marked *pannus* can be seen growing over the articular surface of the cartilage in the early stage having spread there from the synovial membrane As a consequence of this stripping up of articular cartilage the underlying bone is exposed and a tuberculous osteitis develops The cavities in the cancellous bone which result are first filled with granulation tissue and caseous matter and then caries of the bone takes place When the articular cartilage and ligaments have been destroyed pathological dislocation is apt to occur especially in the hip and knee if these are not adequately splinted in a correct position during the stage of *destruction*, which may last many months or even years

Should the arthritis progress an abscess is likely to form and either remain within the joint itself or spread outside the capsule and track among the surrounding muscles Such abscesses are liable ultimately to burst through the skin and form sinuses which are lined with typical tuberculous granulation tissue and which may become secondarily infected with pyogenic organisms A tuberculous arthritis under ordinary conditions *seldom terminates in bony ankylosis.* Repair takes place by the formation of a close fibrous union between *the damaged articular* surfaces a bony ankylosis being the result of a secondary pyogenic infection superimposed upon the tuberculous arthritis At any stage in tuberculous arthritis the patient s resistance is liable to break down and a general infection to occur when death takes place *from* miliary tuberculosis. In children the usual mani festation of *such a general* infection is meningitis

In disease of the shoulder joint in adults the bone infection may be a quiet process with few symptoms leading to destruction of part

of the upper end of the humerus a condition known as Caries Sicca (Fig 581) Tuberculous periostitis is seen in association with disease of certain joints notably at the lower end of the humerus and upper end of the ulna in an arthritis of the elbow joint

Clinical History—The onset of a tuberculous arthritis save in exceptional cases, is very insidious Attention may be called to the joint by some aching in it after use or by a limp which is observed by the parents The child may have been noticed to be off colour for a few weeks without any definite complaint being made Limitation of movement *in all directions* the result of an involuntary muscle spasm is the earliest and most constant sign and the affected joint is held in the position of greatest comfort which varies for each individual articulation. Swelling around the joint is apparent in the knee elbow and wrist at an early stage but in the hip and shoulder it is difficult to observe owing to the greater quantity of surrounding muscular tissue

This swelling is due to inflammation of the synovial membrane and only in exceptional cases is there sufficient excess of fluid in the joint to be appreciated on clinical examination. The joint will feel hotter than the corresponding one on the other side of the body

Pain is not an important symptom in the early stages of a tuberculous arthritis, though it is often pronounced when an abscess is present under tension, or erosion of the cartilage has occurred rapidly It may also be present at night in the form of "night cries which are explained by the fact that as the patient drops off to sleep the muscles, which have been in spasm, at once relax and the inflamed surfaces by being rubbed together again stimulate the return of muscle spasm, which wakes the patient with a cry Muscular wasting is obvious at a very early stage

The *diagnosis* is by no means always easy, especially in the early stages but as a general working rule any subacute arthritis with an insidious onset in a child should be regarded as tuberculous until the contrary is proved, and if this rule is followed faithfully very few errors will be made Disease in the bone although not involving the joint may give rise to symptoms which are similar to those of an arthritis. In the knee Clutton's joints may lead to error especially if the second knee has not become swollen. X ray examination of a suspected joint will in the early stages reveal little except that in most joints the synovial membrane is shown to be thickened. It is only when articular cartilage has been destroyed and there is destruction of bone that changes will be shown in an X-ray Thus the diagnosis must be made in the early stage on clinical signs alone In certain joints where a definite diagnosis cannot be made otherwise it is desirable to perform an arthrotomy in order that a specimen of the synovial membrane may be removed for histological examination In adults the diagnosis of a tuberculous arthritis may be very difficult indeed, because the early signs and symptoms are often not in any way characteristic and in fact impossible until the patient has been under close observation for a considerable period of time

Prognosis—As regards life the prognosis depends upon the patient being treated under good conditions and the general resistance to the disease improved but even so there is a mortality whilst under

treatment of between 5 and 10 per cent Patients in whom treatment is commenced early are more likely to respond favourably than others nevertheless early treatment of the local lesion does not prevent the disease in the joint progressing However early a tuberculous arthritis of the hip or knee is treated the disease under any conditions goes through its cycle of activity with tissue destruction, gradual repair and finally quiescence for except in a few instances the disease can never be said to be cured but only rendered quiescent For all practical purposes this is as good as a cure but there always remains the possibility of a recrudescence of the disease

Whilst the prognosis of a tuberculous arthritis varies enormously with different patients and different joints in general it is bad if more than one large joint is the site of disease whilst if several small joints are involved the prognosis is usually good The outlook in senile tuberculosis is extremely poor

Complications —1 **Abscess Formation.**—This is an indication of the activity of the disease The more virulent the infection and the more active the destruction of bone the more likely is abscess formation to take place It may develop quietly without any symptoms and not be noticed until of considerable size There is no heat or redness and the skin is involved over it at a late stage Such an abscess is painful only if it develops rapidly before the joint capsule has had time to soften and stretch the sudden rise of tension within the capsule being responsible for the pain.

2. **Sinus Formation** results from an abscess either bursting being incised or repeatedly aspirated. In the old days sinus formation was always looked upon as a serious complication in that it was certain to become infected with pyogenic organisms, as a result of which the patient would ultimately die of lardaceous disease At the present day under proper conditions of treatment this risk is very slight and when the underlying focus of disease has been rendered quiescent the discharge ceases and the sinus heals up although this may require several months of treatment.

3 **Generalised Tuberculosis.**—At any stage of the disease the resistance of the patient is liable to break down and a general infection to occur If this should happen a generalised miliary tuberculosis develops and the patient generally dies from a tuberculous meningitis the onset of which is heralded by a sudden rise of temperature without any obvious cause accompanied by headache and pain in the back.

Treatment —1 **General.**—In all patients suffering from surgical tuberculosis it must be remembered that the local lesion is only one manifestation of the disease This cannot be emphasised too often Although there may be no other signs which can be identified infection is present elsewhere either in the mediastinal or abdominal lymphatic glands The more carefully a patient is examined the more frequently is pulmonary phthisis found either as an old healed lesion or as an active lesion giving rise to no symptoms

The object of treatment must therefore be to assist patients to build up their general resistance so that they may be able to cope with the local disease

All patients with surgical tuberculosis should be treated where possible in the fresh air and it has long been generally recognised that they improve when removed to the country The value of sunlight is difficult to assess It is probable that it does good principally in that it increases the feeling of well-being, as it does in the normal individual. It is unlikely that it has any specific action upon the tuberculous process and an excessive exposure to the sun may be definitely harmful.

The diet should be a good mixed one which patients enjoy but there should be no effort to force them to take more than they desire. Living and sleeping in the open air will rapidly develop a good healthy appetite

The value of streptomycin in the treatment of joint tuberculosis is at present difficult to assess, but it has the most striking effects upon discharging sinuses, which have become infected with pyogenic organisms, for these heal up often in a few weeks.

2. Local Treatment—A *Conservative*.—The main principle to be observed is *rest* with fixation of the diseased joint either by splints or plaster until all signs of active disease have completely settled down. The actual length of treatment will vary with each joint and depends very largely on the general condition of the patient If there is to be any chance of success fixation for a lengthy period is all important and any attempt to reduce the period merely courts a recurrence of activity During treatment care must be taken to watch for the appearance of an abscess which may develop to a large size without having revealed any sign of its presence

When the activity of the local lesion is settling down, the general condition of the patient will commence to improve. The child will put on weight and take a more lively interest in its toys and life in general.

B *Operative Treatment*—It is now generally recognised that surgical measures are not desirable in the routine treatment of an active tuberculous arthritis especially in children, on account of the danger of increasing its virulence Surgery has nevertheless a useful part to play in treatment provided that its limitations are recognised. It used to be thought that by surgical methods the period of conservative treatment might be shortened but it is appreciated now that this is not so in practice In a few instances during the active stage it may be necessary to remove a sequestrum which has formed in the end of a bone before the sinus leading down to it will heal and the bone disease become quiescent Before any other kind of operation is performed a prolonged period of conservative treatment must be given a trial. The main principle underlying any operation is the splinting by internal fixation of a joint which has already been damaged by disease

Arthrodesis or fixation of a joint is an operation which aims at the removal of any infected tissue together with the articular surfaces so as to provide two raw bone-ends which will fuse together with osseous tissue and thus prevent any further movement taking place This operation is chiefly indicated in the hip and knee in children where conservative treatment has failed. In the hip such an arthrodesis is not usually done at the present day because it generally fails to achieve the desired end, namely a bony ankylosis therefore the

operation of so-called *extra-articular* arthrodesis is preferred the joint being fixed by means of a bone graft placed in close relationship to the joint a procedure which does not require any interference with the diseased tissue itself or at any rate to only a minimal degree. The older operation of excision of the joint whilst it may still be performed under suitable conditions in adults has been given up in children on account of the danger of damaging the epiphyseal cartilage, thereby interfering with the growth of the limb

Amputation is called for in those patients in whom other measures have failed *Seldom* does such a need arise in children but in adults amputation has a definite place in the treatment of tuberculous arthritis It is impossible to lay down any general rules for deciding when it is called for and each case must be judged on its own merits



FIG. 575

An early tuberculous focus in neck of the right femur which has not yet affected the joint.

TUBERCULOUS ARTHRITIS OF SPECIAL JOINTS

THE HIP

Tuberculous disease of the hip joint commences as frequently in the synovial membrane as in the bone In the latter it may start either in (1) the upper lip of the acetabulum (2) the epiphysis of the head or (3) the neck of the femur (Fig 575) Wherever it starts the disease sooner or later in spite of treatment involves the other structures of the joint If not treated adequately progress of the disease is rapid and marked. As with other joints the hip is more commonly affected in children than in adults but in the latter the prognosis is more serious both as regards the local lesion and the general health of the patient

Clinical History.—Parents commonly come for advice having noticed that their child has been less active than normally has been observed to limp and tires easily Pain except in rare instances when abscess formation is early and rapid, is not a prominent feature but when present it may be complained of either in the hip itself or on the inner side of the knee Whilst the history of some injury can often be elicited rarely do the parents associate the onset of the limp with this until they are questioned.

Tuberculous arthritis of the hip may be divided into two stages —

First Stage.—The hip is held with the thigh in flexion abduction and external rotation and in consequence the leg on the affected side appears to be longer than that on the sound side (Fig 576) The child stands with a lumbar lordosis to compensate for the fixed flexion of the joint. The true position in which the joint is fixed, can be demonstrated by laying the child on its back and flexing the sound

thigh upon the abdomen, thus obliterating the lumbar lordosis when the affected thigh will be raised from the bed and the true angle of fixed flexion of the diseased hip can be demonstrated The movements of the hip joint are limited in *every direction* and in the really acute stage movement is completely abolished. This is the direct result of an involuntary muscular spasm Muscular wasting is seen very early and can be demonstrated most easily in the gluteal muscles where the buttock is flattened and the normal gluteal fold is lost.



A B

Fig. 576

A, front view of a boy with tuberculosis of the right hip. Note the abduction and eversion and the apparent lengthening of the leg. B, lateral view of the same child showing the flexion of the hip.

Little swelling is to be noticed around the joint and though occasionally an abscess may already be present it is impossible to demonstrate its presence whilst confined within the capsule and until it reaches an appreciable size In such an early case as this an X ray will reveal either nothing abnormal or at the most only slight decalcification of all the bones entering into the formation of the joint while the obturator foramen looks smaller than its fellow (Fig 577) This sign is the result of muscular spasm rotating the pelvic bones and indicates that the disease has been present for some time As pathological changes progress if the condition remains untreated there may be no other signs but in a number of patients pain increases and there are night cries

Second Stage.—In this stage damage has been done to the joint and the position of the thigh has altered The hip is now held in flexion adduction and internal rotation the degree of flexion being more marked than before No very satisfactory explanation to account for this alteration in position can be offered It is usually supposed to be due to stretching of the capsule with destruction of bone allowing the femoral head to subluxate backwards and upwards and thereby permitting the adductor muscles (which are the strongest) to pull the thigh over into the position of adduction and internal rotation (Fig 578) With the hip in this position the limb will now be found to have apparent shortening *in contrast to the apparent* lengthening which was present in the first stage The amount of true shortening will depend upon the degree of bone destruction and, if this is appreciable the great trochanter will be found to be raised above Nélaton s line



Fig. 577
X ray illustrating the early changes in a tuberculous hip (left), as described in the text.

In spite of treatment as has been already stated this disease of the hip joint is progressive The likelihood of an abscess forming depends upon the rapidity of progress and the degree of bone destruction Fixation will not prevent it if the lesion is very active An abscess may track and present anteriorly between the anterior superior spine and the great trochanter it may appear behind in the gluteal region or occasionally it is found on the inner side of the femoral vessels in the adductor region When the disease commences in the acetabulum an abscess may form inside the pelvis as a result of perforation of its floor by tuberculous granulations but such an occurrence is rare The final condition of the joint will depend upon the amount of destruction of bone and the position of the limb whilst under treatment If no fixation is employed the diseased bone will be damaged by movement for the osteitis so softens it that pressure adds to its destruction and the remnant of the head of the femur becomes completely *dislocated backwards* upon the dorsum ilii. This condition which should not be allowed to occur leads to great difficulty in treatment



Fig. 578
Advanced tuberculous disease of the left hip, the limb being adducted. There is great destruction of bone and an abscess cavity is well defined by its mottled calcification.

Diagnosis.—The diagnosis of a tuberculous hip in the early stages may be most difficult. From its clinical signs the only possible diagnosis is that of an arthritis of the hip joint. Since the commonest form of subacute or chronic arthritis of the hip joint in children is tuberculous such a condition in a child should always be regarded as such until the contrary is proved. A child of the age when surgical tuberculous lesions are common is liable to minor strains or injuries and to develop a limp associated with muscular spasm. This is a mild traumatic synovitis, which clears up within a week or ten days with rest in bed

There are also a certain number of cases of mild arthritis of unknown origin in children which clear up completely with rest, though such treatment may need to be continued for several months These hip conditions cannot be differentiated from a tuberculous arthritis in the early stages They all have the same signs and symptoms The only way to arrive at a correct diagnosis is to treat them as though they were tuberculous until all signs of arthritis have completely subsided Then, if with increasing activity there is no recurrence of the signs and symptoms the arthritis is not tuberculous, for if it were increased activity would soon bring about a return of muscular spasm with resultant loss of movement evidence of the persistence of the arthritis **Pseudocoxalgia** should be differentiated from a tuberculous arthritis in most cases with ease It occurs at an age period somewhat later than a tuberculous hip Also in pseudocoxalgia, whilst movement is limited by muscle spasm, it is not limited in all directions. Flexion is nearly full in range whilst abduction in flexion is almost completely absent So also is muscular wasting, while a positive Trendelenburg's sign is usually present. The X ray pictures in the early stages may be a little difficult to differentiate but in the ordinary way typical changes are present in the head and neck, and the diffuse atrophy of the bones which is present in a tuberculous arthritis is absent in pseudocoxalgia. The presence of spinal caries, which gives rise to spasm of the psoas muscle producing a flexion deformity of the hip joint, may lead to a mistake in diagnosis.

The *prognosis* is uncertain as regards both the joint itself and also life As with any other tuberculous lesion there is a definite mortality —between 5 and 10 per cent With regard to the diseased joint it can truthfully be said that early and efficient treatment will give a better result than if the disease is permitted to progress for weeks or months without treatment But however early treatment starts it will not prevent further damage being done to the structure of the joint which goes through its cycle of inflammation, destruction of tissue and attempted repair however early and perfect treatment may be A child with tuberculous disease of the hip never recovers any useful range of movement The usual result when the disease is quiescent is a close fibrous ankylosis Such an ankylosis is unable to resist all the strains and stresses which subsequently fall upon it when activity is resumed and the thigh in course of time often in a few months becomes flexed, adducted and internally rotated although at the end of treatment it may have been a little externally rotated and abducted

Treatment—Rest in recumbency with adequate fixation of the diseased joint in slight flexion and abduction is the underlying principle of all methods and these must be continued uninterruptedly for a minimum period of two years whilst considerably longer is necessary in certain patients The particular method of fixation employed does not much matter so long as those treating the patient are thoroughly familiar with it The Robert Jones's abduction frame (Fig 579) provides the most perfect fixation possible whilst at the same time allowing the joint to be under observation The child is kept on this frame until all signs of active disease have completely subsided, all muscle spasm has disappeared and X ray shows that destruction of bone has ceased and that the affected bones have recovered their density This may not occur until the end of the third year or even longer though generally two years is sufficient The child having been removed from its frame a plaster spica, moulded well in to fix the pelvis is applied to the affected hip down to but not including the knee The child is permitted a certain amount of freedom in bed and later is allowed up walking in this plaster with crutches If all goes well, these are gradually given up and active walking in the plaster is permitted. This is continued for a period of another twelve months If at the end of this time there are no signs of active disease either clinically or radiologically the child is allowed to dispense with retentive apparatus and is kept under close observation, X-rays being taken from time to time Unfortunately in the majority of patients this does not end the story The child has been left with an unsound fibrous ankylosis and although the hip joint at the end of treatment may be apparently fixed in a position which is functionally satisfactory i e. slightly flexed and abducted within the space of one or two years it becomes more flexed and adducted with some internal rotation whilst in a certain number a recrudescence of the disease occurs the most common sign being the development of an abscess In an endeavour to avoid these troublesome sequelæ it is becoming the custom to fix the hip by an extra articular arthrodesis performed when no signs of active disease are present the graft being taken either from the tibia femur or outer wall of the ilium The joint is then fixed in a short plaster spica

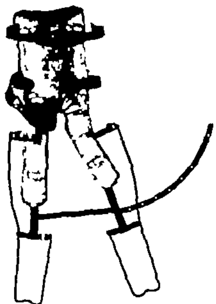


Fig 579
A Robert Jones's abduction frame.

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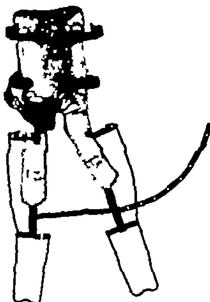


Fig. 570
A Robert Jones's abduction frame.

which is kept on until the X ray shows that consolidation has taken place. *It must be clearly understood that this operation is not intended to replace the conservative treatment previously described* Its sole function is to fix a joint which having been already damaged by disease is no longer capable of standing up to the strains which it may be called upon to bear in the ordinary wear and tear of life

Abscess Formation.—The development of an abscess in a case of tuberculous arthritis is an indication of the activity of the disease Treatment is necessary as if pus is permitted to track among the muscles of the thigh, a tuberculous myositis results and this makes it very difficult to obtain any improvement in the joint condition (Fig 578) If the contents of the abscess are liquid, it may be treated by repeated aspirations under careful aseptic precautions If, however the abscess is filled with thick caseous material this will not pass through the needle when aspiration is attempted. In such a condition various fluids have been injected into the abscess with the object of liquefying the caseous contents so that subsequently they may be aspirated. It is however much more satisfactory to incise the skin over the abscess remove the mass of caseous material under strict aseptic precautions and suture the skin carefully afterwards Many abscesses treated in this way heal by first intention and do not re-form. Those which do break down form a sinus discharging tuberculous pus and this continues to leak out until all signs of active disease in the joint have entirely settled down, when the sinus will heal up rapidly Under good conditions in a country hospital these abscesses even if opened do not become infected with pyogenic organisms as was the experience of surgeons in the large general hospitals thirty or more years ago

When a tuberculous arthritis of the hip has been neglected or if symptoms have never been serious enough to call for treatment (and this does happen) the joint is found to be fixed in about 90 degrees flexion with marked adduction and internal rotation, and a great amount of apparent shortening

Under these circumstances it is desirable to perform an osteotomy below the trochanters and to fix the limb in the best functional position. About 30 degrees of flexion are necessary to enable the patient to sit down in comfort and a few degrees of abduction to compensate for the true shortening that is present Too wide an angle of abduction especially if combined with flexion of the hip joint, will result in an ugly gait

Tuberculous disease of this joint in an adult offers quite a different problem The diagnosis is very much more difficult Sometimes the onset is very acute and the patient s power of resistance poor whilst in other instances all that can be diagnosed is a subacute arthritis The presence of tuberculous lesions in the lungs will be very strong evidence as to the nature of the hip arthritis but even then it may be several months before a certain diagnosis can be made Treatment by recumbency with fixation is just as important in the adult in the early stage but the disease is seldom likely to settle down except with considerable destruction of bone and upon occasions excision of the

damaged head of the femur may be required The prognosis of an acu tuberculous hip in an adult is poor both as regards the joint and th duration of life

The Knee

Tuberculous disease of the knee in the vast majority of patien starts in the synovial membrane and only at a later stage affects th articular cartilage and bone by direct spread As in the hip treatmen does not prevent the spread of the disease although it may delay i progress. When the disease begins in bone it does so generally the metaphysis, and infection spreads to the joint only after an interva There may be present a sympathetic synovitis which will subsid completely if the bone abscess is incised and drained in time

Signs and Symptoms—The patient complains of swelling or stif ness of the joint and also that the knee has become bent so that h is no longer able to straighten the limb and has to walk on his toes

Pain is a variable symptom and is not a prominent feature in mo knees When a young infant a few months old develops a tuberculo knee pain may be marked so much so that it may appear to be pyogenic arthritis

Thickening of the synovial membrane is sometimes very mark and its attachments to the margin of the articular cartilage on t lower end of the femur are tender In young infants the effusion often great but in older children and adults there is but little exce of fluid in the joint.

Muscular wasting especially of the vastus internus, is presen whilst the hamstring muscles are in spasm In the majority of tube culous knees the X ray examination reveals nothing except a gener decalcification of the bones and thickening of the synovial tissu Only after the disease has been present for many months or if treate for some years does it reveal any signs of caries or erosion of bon In young children the lateral X rays of the two knee joints on comparis in the early stages will show that the patella on the affected side h started to ossify earlier than that on the sound side and that ossification has proceeded more rapidly This X ray appearance practically diagnostic of a tuberculous arthritis starting in the synovi membrane When a tuberculous knee has been neglected a trip deformity occurs in consequence of the destruction of the joint surfac and ligaments and as a result of the spasm of the hamstring muscl The joint becomes markedly flexed the tibia subluxated backwar and externally rotated Such a deformity is seldom seen at the prese day but if attention is not paid to the method of fixation duri treatment it is possible for the tibia to rotate externally and subluxa backwards unobserved

Diagnosis—Any chronic synovitis of the knee in a child with lit pain but muscular wasting should be regarded as tuberculous un the contrary is proved The absence of pain might lead one to consid the possibility of it being a Clutton's knee, a condition which can excluded by the absence of muscular spasm, and by the presence more effusion than is usual in a tuberculous knee other congeni

syphilitic stigmata and a positive Wassermann test An abscess in the lower end of the femur or upper end of the tibia, either tuberculous or pyogenic may be associated with a sympathetic effusion into the joint. An X ray will reveal the presence of such a lesion. There occur in children a few cases of chronic synovitis which clinically are indistinguishable from a tuberculous knee. It is therefore justifiable if no other means will settle the correct diagnosis to do an arthrotomy and remove a specimen of the synovial membrane for histological examination If the condition is tuberculous the diagnosis can be definitely established, whilst it is known that these other cases of chronic synovitis of unknown origin clear up completely after an exploratory arthrotomy Every now and again a patient will be seen in whom a chronic synovitis is associated with a gummatous osteitis and therefore it is wise in all children with a chronic arthritis of the knee joint to have a Wassermann test done as a routine

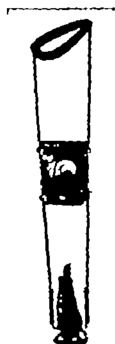


FIG 580
A Thomas s walking caliper splint.

A chronic effusion into the joint is often the accompaniment of a sarcoma of the lower end of the femur but the history of pain associated with a sarcoma and the X-ray appearance should reveal its true nature In an adult the diagnosis from a villous arthritis may be very difficult especially as it sometimes happens that this joint is the only one affected. An arthrotomy may be the only method by which the diagnosis can be made

A gummatous synovitis is in many respects similar to an early tuberculous arthritis in the adult and as in the child, a Wassermann test as a routine is indicated. Pain is a more prominent symptom in the adult with a tuberculous arthritis than in the child, because the destruction of the joint surfaces occurs more rapidly in the former

Treatment —Rest combined with fixation in a Thomas s knee splint is essential in every patient during the acute stage Such immobilisation must be combined with a fixed extension for a weight and pulley allow movement at the joint. If pain is a prominent feature it rapidly subsides with adequate extension and fixation. Rest in bed must be continued until all signs of activity have been absent for at least six months Then the patient can gradually be allowed up in a walking caliper (Fig 580) and even if no signs of activity return he must retain this for at least two to three years Abscess formation is rarely seen in a tuberculous knee The usual history in a child after conservative treatment is that for perhaps a year or more the disease remains quiescent and that then symptoms recur After a further period of conservative treatment the condition settles down only to recur again at a later date By this time the X ray which may never have revealed anything definite before except for enlargement of the patella and a diffuse bone atrophy

will begin to show erosion of the ends of the bones It has been found that sooner or later all tuberculous knees with very few exceptions require an arthrodesis, which in older children can be done without interfering with the growth of the limb by removing only the articular cartilage on the femur tibia and patella together with the diseased synovial membrane and any remnants of the ligaments

The limb is then fixed in plaster and after a few weeks the child is allowed to bear weight on it Bony ankylosis will occur but it may take as long as two years during which period some form of fixation is called for as otherwise a fibrous and not a bony ankylosis will result and the knee gradually bend. Once a firm osseous union has taken place the patient is unlikely to have any further trouble.

The treatment of a tuberculous knee in an adult depends very much upon the age of the patient It is always a more virulent disease than in a child and no surgical methods must be employed which aim at fixation of the joint while this activity persists. In young adults the same treatment as for children is called for until the knee is quiescent, and then an arthrodesis or excision of the diseased joint should be done Fixation in plaster or a splint must be continued until bony ankylosis is firm If an arthrodesis or excision is performed during the active stage it is probable that the disease will become more active still and multiple sinuses develop a condition which may necessitate amputation as a life-saving measure

When a tuberculous knee develops in an adult over the age of forty years, a long period of rest in bed with fixation often proves difficult for the patient and it is still more difficult to obtain a bony ankylosis by means of an arthrodesing operation An amputation through the middle third of the thigh well away from the disease must then be considered. People of this age seem to have lost the power of local resistance and any attempt at arthrodesis is likely to fail.

In those cases in which a tuberculous osteitis is associated with a sympathetic synovitis of the knee joint, the focus in the bone must be explored and curetted out as soon as it is diagnosed the incision afterwards being closed It may heal by primary union or at the worst a sinus develops which discharges some thin pus for a few weeks before finally healing up Left untreated such an osteitis always spreads ultimately to the joint cavity whereas with early drainage of the bone abscess the joint can be saved and the sympathetic effusion will rapidly subside

The Ankle

Disease of this joint in most instances begins in the synovial membrane very rarely does it originate from an osseous focus The joint becomes stiff and painful. Swelling, which is marked, shows itself on the posterior aspect of the joint on either side of the tendo achillis Muscular spasm holds the foot in a position of equinus and in a child the development of a limp is often the first sign that may be noticed The joint surfaces become involved more rapidly than they do in the knee and therefore pain is complained of earlier In the adult an X ray will in most instances reveal destruction of articular cartilage

by the time advice is first sought Abscess formation is very common both in children and adults

Treatment.—In the child fixation in plaster without any weight bearing if continued for a sufficiently long period, results in a firm fibrous ankylosis If an abscess forms in spite of aspiration it usually breaks down with the formation of a sinus which heals in time without any difficulty Such an ankle joint is liable in young adult life to be a source of further trouble from a recurrence of activity When a tuberculous arthritis develops in an adult conservative treatment gives very poor results Excision of the joint is liable to be followed by increased activity of the disease and in most patients the only satisfactory treatment is an amputation through the tibia 7 in below the knee joint certainly in any adult over the age of 30 years this is the only treatment of any value though many will hesitate to accept such advice and prefer to try conservative treatment for a year or more



Fig 581
Caries sicca of the left shoulder joint

Tarsal Joints

Infection of these joints is the result of an osteitis of one of the tarsal bones which spreads infection direct into the neighbouring joints. This is very rare in adults.

Treatment consists in fixation in plaster until all signs of active disease have settled down. In nearly 100 per cent. of cases an abscess develops and as long as there is any osseous disease the sinus which results will continue to discharge At times a carious sequestrum will form in one of the tarsal bones and necessitate removal by operation before the joint condition will clear up

The Shoulder

Disease of this joint is seldom seen in children It is usually secondary to a tuberculous osteitis of the upper end of the humerus from which the joint becomes infected In young adults it occurs quite often when active pulmonary disease is also present In these cases pain is not a prominent feature but there is loss of movement and a considerable amount of swelling Muscular wasting of the deltoid especially is marked The pain if present may be complained of either in the joint itself or down the front and outer side of the arm leading the patient to believe that he is suffering from a neuritis In later life a particular form of tubercle known as *caries sicca* is seen in the upper end of the humerus, and the joint is generally involved by the time advice is sought (Fig 581). Symptoms

are slight limitation of movement being the most common with aching down the arm this having often been present for some time In the young adult in most instances an abscess develops and in the older patient also this may occur It may reveal itself either at the anterior or posterior fold of the axilla but most often tracks down along the tendon of the biceps and appears in the upper part of the arm below the tendon of the pectoralis major forming a fluctuating swelling above the muscular belly of the biceps X ray examination in the adult will generally show destruction of bone whilst in the older patient with caries sicca an osteitis of the head of the humerus with the formation of small sequestra is revealed

Disease beginning in the tuberosity if identified in time may be dealt with by surgical means and the joint saved from infection but this unfortunately is seldom practicable

Treatment consists in fixation of the shoulder in abduction to 90 degrees and slightly in front of the coronal plane of the body either in plaster or upon an abduction splint. Any abscess which forms must be aspirated repeatedly but many of them burst through the skin and form sinuses which may take several months to heal If the disease in spite of adequate fixation shows no sign of settling down a formal excision of the joint removing all the diseased tissue may be desirable combined with fixation for a long period afterwards Disease of this joint in young adults is so often associated with active pulmonary disease that the prognosis is correspondingly poor

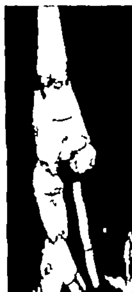


FIG 582

Bones of the arm showing extreme rarefaction and destruction of the elbow joint. In the actual specimen the bones are translucent

The Elbow

This joint is principally involved in young children, the disease starting either in the synovial membrane or the upper end of the ulna It seldom arises either in the head of the radius or the lower end of the humerus The joint becomes swollen fusiform in outline and painful while movement is almost entirely abolished by muscle spasm The grooves on either side of the tendon of the biceps are obliterated and the swelling of the joint is made more obvious by the amount of muscular wasting Abscess formation occurs in nearly every patient, showing itself either on the inner or outer aspect of the joint. Although aspirated repeatedly these abscesses usually break down leaving a sinus which takes a little time to heal. X ray shows destruction of the joint (Fig 582) combined with periostitis of the lower end of the humerus and upper end of the ulna which latter is especially well marked.

Treatment —The joint must be fixed in flexion by slinging the forearm in a collar and cuff or if this is not sufficient to relieve symptoms in plaster Treated thus in children the prognosis is

good both as regards time and function, for a certain amount of movement in the joint is ultimately obtained. In adults excision of the joint may be desirable but it should never be done until conservative treatment has had a good trial and been found wanting

The Wrist

Disease of this joint is much more common in elderly patients than in children or young adults Starting usually in the synovial membrane the joint slowly becomes puffy swollen and painful. There is also gross limitation of movement in all directions and the carpal bones after a time become extensively diseased Pain may or may not be a common feature

Treatment —Fixation in plaster for several months is necessary the fingers and thumb being allowed free to move whilst the wrist itself is held in slight dorsiflexion. Treated thus most wrists do very well but if damage to the carpal bones is extensive and does not settle down with fixation alone it may be necessary to explore the joint through a dorsal incision and remove with a gouge any obviously diseased bone.

The Sacro-iliac Joint

Tuberculous disease of this joint is not uncommon especially in adults It commences in the neighbouring bone of the ilium and is characterised by the paucity of symptoms to which it gives rise The patient may complain only of having had a tired feeling in the lower part of the back for some weeks or months and upon examination may be found to have an abscess forming either on the posterior or anterior aspect of the joint In the latter case unless it is very large and can be felt through the anterior abdominal wall its presence is revealed only by rectal examination. The patient may walk with a limp keeping the hip on the affected side flexed, but the most out standing feature of disease of this joint is the entire absence of any pain until a late stage.

X ray examination will reveal caries of the ilium in the region of the joint by the time symptoms are severe enough to call the attention of the patient to the back.

The *prognosis* is good in children and uncertain in adults whilst the latter usually recover from the local lesion they appear very liable to develop another bone lesion at a later date

Treatment —Fixation upon a plaster bed in some form of frame is necessary for a long period. In many patients an abscess develops and finally discharges leaving a sinus leading down to a sequestrum which must be removed before the sinus will heal

Attempts to arthrodese this joint are not satisfactory and are liable to result in a spread of the disease to the surrounding bone

TUBERCULOUS DISEASE OF THE SPINE

Pathology

In common with tuberculous infections of bones and joints elsewhere Pott's disease occurs most often in children under the age of

10 years Thereafter its frequency diminishes and though it may occur at any age it is a comparatively less rare disease in the adult The male is rather more prone than is the female Injury has no more association with the development of a tuberculous focus in the spine than it has elsewhere The dorsal and dorsi lumbar regions are the most common situations for the disease to develop, probably due to the fact that a greater strain falls upon this portion of the spine The cervical and lumbar regions are involved about equally but taken together disease in these situations is only half as common as in the dorsal region The infection of the spine is commonly believed to be due to the bovine bacillus more often than to the human.



FIG. 583
A specimen illustrating the early changes in the body of a vertebra in Pott's disease (see text).

The tuberculous process is identical in its development with lesions in other parts of the skeleton. Except in rare instances it



FIG. 584
A small boy showing marked kyphosis in the dorsal region This is due to the collapse of not more than two vertebræ.



FIG. 585
X-ray illustrating kyphosis due to the complete collapse of one vertebra and the partial collapse of another

commences in the anterior portion of the body of a vertebra close to the epiphysis (Fig 583) A periosteal site of infection as opposed

to this endosteal type occurs in the adult but by the time the patient seeks advice it has usually advanced to a stage at which it is impossible to differentiate the two As the result of the development of the tuberculous focus caries occurs and the portion of the bone affected becomes softened and breaks down into a caseous mass The disease may very rapidly involve the intervertebral disc and having infiltrated this spread thence to the adjoining vertebra. It may also spread from one vertebra to another beneath the anterior common ligament

The anterior portions of the two vertebral bodies becoming softened, collapse slowly under the weight of the trunk and the typical deformity of an angular kyphos is produced by the projection backwards of the spinous processes (Figs 584 and 585) The acuteness of this kyphos will depend upon how many vertebræ are involved by the disease It may spread so that several are affected at more or less the same time and then a more gradual curve results Especially in children more than one portion of the spine may be affected, and this has been more appreciated since routine X ray examinations have been carried out during treatment



FIG. 586
Tuberculous disease of the 7th cervical and 1st dorsal vertebræ.

Although disease may commence in any portion of the neural arch, in practice it is rare for it to develop in the lamina or spinous process

In the cervical and lumbar regions a kyphos is not so marked as in the dorsal vertebræ In the cervical region, in addition to commencing in the bodies of the vertebræ (Fig 586) the disease occasionally appears in the joints between the atlas and axis and the bone is affected at a later stage

An abscess or its remains can be found in all those patients who come to autopsy When the disease becomes quiescent and repair takes place in the damaged vertebræ it does so in the first place by a fibrous ankylosis Later this is replaced by a bony union, which may take several years before it is complete Little if any callus is formed in the healing process after caries of the spine If the patient has been allowed to resume the upright position before such repair has taken place and has not been provided with an adequate support there is a grave risk that the kyphos may increase in extent due not always to progression of the disease but simply as a result of further collapse of the damaged vertebræ

The proximity of the spinal cord to the site of disease leads nc infrequently to its becoming involved by pressure from an absce which has tracked posteriorly or rarely from being stretched ove the deformed vertebræ in front of it.

Clinical Picture

The onset of spinal caries may be very gradual or quite acut but the former is the more common. In consequence the history whic the parent gives may vary considerably The child may be brougl because it is limping has pain in its back or abdomen, or as the resu of a lump having been noticed in its back whilst being bathed Probabl the appearance of a kyphos is the commonest early manifestatio which is noticed in hospital practice Very rarely the child will b brought up for examination because of weakness of the lower limbs

In the adult any of these reasons may bring the patient unde observation whilst occasionally a swelling in the abdomen or bacl the result of an abscess, attracts notice by its size or pain.

It must therefore be realised that the early stages of the diseas in many patients give rise to few symptoms and that, save in a fe instances the disease is already well established before it can l recognised clinically

Pain is not always an early symptom. It is more common for tl patient to complain only of having had an indefinite ache in the bac which, especially in the adult is apt to be regarded as a mild lumba or back-strain.

Pain, when it is present may be of two kinds It may be *loc* over the site of disease made worse by any kind of movement or may be *referred* produced by pressure upon or irritation of the ner trunks as they emerge from the intervertebral foramina. When d to this latter cause pain will vary in distribution according to tl portion of the spine affected. In disease of the cervical region it complained of in one or other arm in the dorsal sector it will l referred to the abdomen, whilst in the lumbar region it affects t legs and in the adult may be regarded as sciatica.

Rigidity.—Stiffness always occurs in tuberculous disease of t spine In the early and active stages before the appearance of kyphos rigidity is due to a reflex involuntary muscular spasm whi is nature s method of splinting the inflamed portion of the spir This spasm may be of such a nature that it is quite obvious up examination of the spine that the muscles are contracted and th they are preventing any attempt at movement. In disease of t lumbar and cervical regions the muscles may be seen in spasm mo readily than in the dorsal spine whilst in cervical caries the head a neck will be carried a little forwards and held immobile In childre when muscular spasm is not as marked as this it may difficult to demonstrate its presence To invite the child to put t spine through its range of movement may be impossible on accou of its age The existence of muscular spasm can, however be elicit by placing the patient on its face upon a couch, then raising the low

limbs and noticing the degree of extension of the spine which can be obtained and also the lateral mobility If rigidity of the spine is present movement will be limited.

Alterations of gait are common in spinal caries and are due to the trunk being held rigid by muscular spasm so that the patient does not twist his spine when looking round or bend it when stooping instead he flexes the lower limbs in order to do so In cervical disease a torticollis may develop or the child may support the chin upon his hand.

In the late stages of the disease rigidity is of course due to the fixation of the damaged vertebræ either by a fibrous or bony ankylosis

Deformity —It has already been stated that the characteristic deformity in a tuberculous spine is an acute angular kyphos. This is the usual case where only two vertebræ are affected but when several vertebræ are involved the deformity may be angular but more rounded. The deformity is more easily recognised in the dorsal region of the spine, owing to the spinous processes being longer and hence protruding relatively further when their bodies have been damaged. In both the lumbar and cervical regions there may be very little actual deformity only a loss of the normal concavity which exists in these portions of the spine. In the cervical region in children the contraction of the spinal muscles will flex the occiput backwards and thus the child will appear to have lost its neck.

In patients in whom many vertebræ in the dorsal region have been damaged and no satisfactory treatment carried out the sternum is likely to be deformed and the ribs crowded together the patient becoming the typical hunchback, a condition seldom seen at the present day

Abscess

In practically every patient an abscess developes at some stage of the disease but it may never be of sufficient size to be recognised as a clinical entity though it is revealed upon radiographic examination

An abscess may grow to a large size before it is recognised, since its production is often painless and it commonly develops even some long time after treatment has been instituted. This is particularly so in adults and in caries of the lumbar spine the swelling caused by the abscess may as has already been pointed out be the reason for the patient first coming for advice

In children an abscess does not usually occur until a later stage of the disease Its size and rapidity of development as in all other tuberculous lesions is an indication of the activity of the disease

The abscess forms beneath the anterior common ligament and may strip this up for a considerable distance from the bodies of the vertebræ. It may remain localised at the site of disease and be gradually absorbed, or it may increase in size and track in various directions, according to the portion of the spine from which it originates and so become a clinical feature of the disease.

In the *cervical* region a retropharyngeal abscess appears in one of two situations. It may show itself behind the posterior wall of the

pharynx and pushing this forward, cause a fluctuating swelling which interferes with swallowing and breathing In the early stages the posterior wall of the pharynx is freely movable but unless the tension of the abscess is reduced, it becomes adherent Instead of accumulating here the abscess may track laterally behind the carotid artery and jugular vein and appear in the posterior triangle of the neck behind the sternomastoid muscle Very rarely in cervical disease an abscess may instead of tracking in either of these directions make its way down either into the mediastinum or into the axilla along the trunks of the brachial plexus.

In the *dorsal region* the abscess commences in the same way and, although obvious as a shadow in the X ray of the posterior mediastinum rarely becomes a clinical entity It does so however when it extends backwards between the vertebral ends of the ribs to form a dorsal abscess In this region it is more likely than in other situations to track backwards beneath the posterior common ligament and owing to the smallness of the spinal canal to produce pressure upon the cord.

In the *lower part of the dorsal and the lumbar regions* the pus finds its way into the sheath of the psoas muscle producing a psoas abscess (Fig 587) It tracks down forming first an iliac abscess above Poupart s ligament and then travels on behind the femoral vessels to accumulate in the adductor region It may even go further down the thigh or pass with the internal circumflex vessels behind the femur and present on the outer side of the thigh below the great trochanter In very rare instances the abscess tracks into the pelvis appearing again in the gluteal region, or even rupturing into the rectum.

In some patients instead of tracking down the sheath of the psoas muscle it passes backwards between the latissimus dorsi and external oblique muscles presenting then as a lumbar abscess in the triangle of Petit (Fig 588)

The development of a large abscess is of course a serious complication on account of the risk of secondary infection with pyogenic organisms but under modern conditions of treatment this seldom happens

Nervous Symptoms

Though occasionally weakness of the lower limbs may be the first manifestation, this is rare Nervous symptoms are more likely to develop during very active and extensive disease or when efficient treatment has not been carried out for a sufficient period of time They result either from an extension backwards of the disease a mass of granulation tissue or an abscess pressing upon the spinal cord or in later stages from stretching of the cord over the posterior aspect of the damaged vertebræ Owing to the small size of the spinal canal in the dorsal region nervous symptoms are more likely to develop in this situation than in the cervical where there is plenty of room or in the lumbar region, where the cord has broken up into the cauda equina. Owing to their anterior position the motor tracts are the most likely to be involved.

The typical nervous symptoms are a true spastic paraplegia with increased knee and ankle jerks ankle clonus and extensor plantar response whilst incontinence of urine and fæces, either one or both, is usually present

The onset of these signs of pressure upon the spinal cord is usually very gradual and may develop even whilst the patient is under satisfactory treatment When this happens the pressure is due to an abscess and for a time the symptoms will get worse before improvement commences

Such symptoms are very often seen in patients who have a



FIG. 557

Extensive dorsi-lumbar tuberculosis of the spine The calcified outline of a large psoas abscess can be seen on the left side and a slight indication of similar condition on the right.



FIG 558

A large lumbar abscess coming to the surface through Petit s triangle between the erector spinæ and latissimus muscles.

recurrence of the disease and these seek advice again not on account of the back but because of inability to walk properly or of bladder trouble

Occasionally in addition to manifestations of motor involvement, sensory changes even to the extent of anæsthesia, may develop in severe and acute cases Under these conditions the muscular paralysis is flaccid in type and there are diminished and not increased reflexes.

X ray Examination —An X ray of the spine is of course essential in every patient with suspected caries and of the two views the lateral is the more important In early cases all that can be seen is perhaps a little mottling of one or more vertebræ with a diminution in the width of the intervertebral space showing that some change has taken place in the disc When the disease is well

established the damage to the vertebræ and the disc can be easily seen. The presence of an abscess in the early stages is revealed by a fusiform shadow Later this can be clearly seen by calcification in its wall.

PROGNOSIS

Tuberculous disease of the spine *is always a serious condition and* although the risk as regards life with adequate treatment is favourable *there still* remains a definite mortality

As in all other bones or joints even with adequate treatment under the best conditions the disease usually progresses before the process of repair commences Because a patient begins treat ment without any visible destruction of bone there is *no certainty* that appreciable damage will not occur in fact, *some is inevitable* The more acute the onset the more is this likely to occur, and it is always wise to be guarded in prognosis

The patient who has a well marked deformity when first examined often does best The development of an abscess visible on clinical examination, does not of necessity mean a bad prognosis but it indicates that the disease is definitely active In adults the prognosis is not as good as in children but probably only because they are more liable to lung complications

Again, the onset of a flaccid paralysis early in the disease is not in itself a bad omen, as it ensures the patient having adequate treat ment but the development of a spastic paralysis whilst under treatment means that this will need to be prolonged

As in all other tuberculous lesions in children there is a risk of a miliary tuberculosis developing and this may occur without warning at any stage of the disease

DIAGNOSIS

The diagnosis of spinal caries in a child should be easy because in most patients a deformity has already developed and rigidity is a marked feature It may however not be possible to make a diagnosis at once if no deformity exists. When this occurs it needs to be remembered that any child with stiffness of the spine with or without pain, should be suspected of caries until the contrary is proved. *Often the only way of settling the diagnosis* is to treat the child as though it had a tuberculous spine and watch its progress If with rest and fixation the symptoms subside and do not return with increased activity the lesion is almost certainly not a tuber culous spine Should however the rigidity return with activity even in the presence of a negative X-ray treatment must be continued

Other infections of the spine in children are rare and if they occur give rise to more general disturbance The differentiation from scoliosis should give rise to no difficulty but it does occasionally happen that the side of a vertebra is destroyed more extensively than its anterior aspect and then it may not be easy without an X ray to differentiate the conditions

In the adult diagnosis may be much more difficult. If there is an acute kyphos without any history of injury it may be obvious without the assistance of a skiagram, but often in the adult pain and stiffness exist some time before a kyphos is visible Here the diagnosis may be difficult for these symptoms may be due to muscular strains osteo-arthritis rheumatoid arthritis or to conditions such as growths or aneurysms pressing upon the spine Malignant growths usually secondary can be differentiated by the history of the primary and by the fact that the pain is more severe and constant being present at night and when the patient is resting Syphilitic disease of the spine, either as a gumma or as a complication of tabes is rare but does occur and can be differentiated by the presence of other signs. A Charcot's spine develops an acute kyphos very similar to that of a tuberculous spine

Treatment

All patients, although they may have no other manifestation of the disease have other foci and therefore the spine must be regarded as only the local manifestation of a general disease

Treatment must therefore include both general and local measures

General.—Patients must be treated under the conditions which are most favourable for building up the general resistance to the infection For this reason they should be moved out into the country away from large cities Plenty of good simple food is necessary and it should be varied in detail so as to tempt the appetite The value of sunshine is much debated, but its chief value is probably the production of that feeling of well being which is so essential. Fresh air and cold winds act beneficially by raising the general metabolic rate. Sometimes when a patient is not progressing favourably a change from the country to the seaside will provide the necessary stimulus

Local Treatment.—Rest in recumbency with fixation of the spine is the principle to be followed There are various means by which this may be achieved, and it does not matter which method is employed provided it is thoroughly understood.

In a child rest is best achieved by some form of frame—either Thomas or Bradford's or some modification thereof The child is strapped to the frame which rests on a bed with large wheels or upon a carriage which can be moved about the grounds In some children it is advisable during the active stage to fit the lower limbs with extensions to make fixation more secure and in the cervical and upper dorsal regions a headpiece must be attached to the frame to enable the head also to be immobilised At intervals it is necessary to examine the spine and for this purpose a plaster case to fit the front of the child is made (Fig 589) so that the patient may be turned over with the minimum movement of the diseased spine

In adults fixation may be achieved in the same way or if they will not tolerate the frame a plaster bed is made in which they lie and which is raised upon a low wooden platform so that no movement occurs during the necessary nursing attention.

In addition to rest and fixation in the child it is desirable to *produce by hyperextension of the frame* a corrective curve above and below the portion of the spine which is diseased so that when the erect posture is subsequently resumed there shall be less stress upon the damaged vertebræ This hyperextension is achieved gradually by bending the frame backwards It is of course not only impossible but also unwise to attempt to straighten out the spine at its diseased segments as their ultimate fusion is the most satisfactory method of curing the disease

The period of fixation on a frame varies greatly but in children a minimum of two years is indicated even if no abscess develops or no nervous symptoms are manifest It may be necessary however to prolong this period even up to five years or more Few adults will tolerate fixation in the plaster bed for two years whilst in the patient of over 50 years of age a period of recumbency of only a few months is often all that can be achieved.

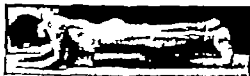


FIG 689

A girl shown in a carrying or turning plaster having been taken out of her treatment apparatus for inspection of the spine

When the general condition of the patient and the skiagram warrant the period of fixation being terminated some form of support must be supplied Of these the Jones's brace or a Taylor support is the most satisfactory and it must be worn for an indefinite period certainly until the skiagram shows that the damaged vertebræ have become ankylosed The child must when released from its frame have exercises to develop its spinal muscles and until these are re-educated it should not be allowed to assume the erect posture In all it must be expected that the child will be under treatment for three years even if no complications develop

In disease of the cervical region a collar must be worn to support the head, one of moulded leather being the most satisfactory

In consequence of further bending of the spine sometimes taking place even after prolonged treatment, two operations have been practised, the aim of which is to provide a living internal splint These operations are —

1 **Albee's Operation.**—The spinous processes of the diseased vertebræ and of two above and below those affected are exposed and split A large graft is then cut with a motor saw from the tibia and sunk in between the spinous processes After this operation the patient remains in a plaster bed for at least three months and then gradually gets up with a back brace which must be worn for a further period of at least a year

2 **Hibbs Operation.**—This is more extensive and was particularly devised for children with disease of the dorsal region. The muscles are dissected off the spinous processes and laminæ until the inter vertebral joints are exposed These are opened and the cartilaginous surfaces removed whilst the laminæ and spinous processes are split

and turned up and down, forming a large number of small grafts which fuse together

Patients upon whom these operations should be performed, require very careful selection and in children there is seldom any reason for their employment They should really be looked upon as operations to splint a spine which has been damaged by disease and which requires some extra permanent support such as cannot be given by a brace.

Treatment of Abscess —If this is not increasing in size neither painful nor showing any signs of involving the skin it can safely be watched as many are spontaneously absorbed. The exception to this is the chronic retropharyngeal abscess which is likely if left to itself to rupture into the pharynx and even if it cause no other trouble to become infected.

The great danger of all tuberculous abscesses is that they may be secondarily infected with pyogenic organisms and for this reason it is wise to treat them by aspiration rather than by incision. In some few instances the abscess must be incised for a variety of reasons but the skin should always be sutured carefully afterwards Should a sinus develop after either aspiration or incision the greatest care must be taken to keep it aseptic by cleansing the skin with surgical spirit and then covering it with a sterile dressing Under the conditions which exist in country hospitals to-day secondary infection of a tuberculous abscess is rare

A Chronic Retropharyngeal Abscess must be aspirated in the neck behind the sternomastoid, and if this does not provide relief it must be incised by this same route Should it rupture into the pharynx it will certainly become infected.

Dorsal Abscess.—This abscess can be aspirated very easily and this should be repeated when necessary

Mediastinal abscesses seldom cause any trouble

Psoas Abscess.—This abscess should be aspirated above Poupart's ligament just internal to the anterior superior iliac spine In spite of this it may continue to accumulate in the adductor region and require aspiration there in which case it is likely ultimately to involve the skin and form a sinus.

Lumbar Abscess.—Aspiration is also indicated, but in adults if it is of great size it is more satisfactory to incise it and suture the skin.

Treatment of Paraplegia —Although the development of paraplegia is a serious complication in a patient with spinal caries it will be found that if and when the disease of the spine gets better the paralysis will likewise improve This may not be for some months but if rest with fixation is persisted in the majority of cases clear up especially if they are of more or less sudden onset In children the paraplegia recovers, except in those patients in whom there has been a relapse in the local condition or in whom the spine has become bent after walking about for some time Even in these if nervous symptoms do not clear up completely they seldom persist to the extent of interfering with the patients ability to walk about

When it can be established that the paralysis is due to the presence of an abscess and this continues to exert pressure relief can be obtained by performing a costotransversectomy to enable the abscess to be drained.

Laminectomy should be performed only in those patients in whom the paralysis can be proved to be due *to pressure from a ridge of bone.* Except under these conditions it does harm and when it is done must be combined with a bone graft to splint the spine which has already been damaged anteriorly by disease and is now further weakened by the laminectomy

SYPHILITIC DISEASE OF JOINTS

Articular disease produced by syphilis at the present day is uncommon as are all the late manifestations of syphilis in consequence of the intensive treatment which, during the last twenty years, has been given for this disease in its early stages In congenital syphilis a diffuse gummatous infiltration of the synovial membrane occurs between the ages of 5 and 15 years. It commonly affects both knees and is known as *Clutton's joints* One knee generally swells some little time before the other though both are always affected in spite of treatment The onset is sudden and the characteristic feature is that of a *painless synovitis in a child for no apparent reason. The* synovial membrane becomes slightly thickened and there is a large effusion into the knee joint without any limitation of movement, except such as occurs in consequence of the amount of fluid present There is no muscular spasm or wasting Other signs of congenital syphilis are often present in particular an abnormal increase in the length of the tibia which is out of proportion to that of the femur The Wassermann and Kahn tests are usually positive

Treatment consists in the usual antisyphilitic remedies Even with these the condition of the joint takes a long time to settle down and, if the effusion has been present for a considerable time a certain amount of laxity of the joint may persist due to softening and stretching of the joint capsule and ligaments Occasionally a child with a syphilitic epiphysitis may develop a synovitis of the neighbouring joint.

In acquired syphilis the following lesions are seen —

1 In the later part of the **secondary stage** vague pains in the joint accompanied by synovitis and an effusion may occur The knee is most often the seat of this condition and in spite of treatment it may persist for a long time

2 In the **tertiary stage** a gummatous synovitis is occasionally seen the knee again being the site of such a condition more commonly than other joints The synovial membrane is thickened and may contain firm nodules The amount of effusion varies greatly Pain as a rule is not very marked, and the chief disability results from the considerable degree of muscular wasting which sooner or later accompanies the swelling In time the stability of the joint is impaired by stretching of the ligaments The diagnosis is often obscure especially when more than one joint is affected. It may under such conditions be difficult to decide whether the disease is syphilitic or a rheumatoid arthritis The Wassermann reaction is often negative and the diagnosis may be finally settled only by the improvement which follows administration of antisyphilitic remedies

3 A chondro-arthritis originally described by Virchow is seen very rarely The synovial membrane is the seat of a gummatous synovitis The cells of the articular cartilage soften and proliferate and then become eroded These eroded areas do not correspond to the sites of intra-articular pressure Erosion and eburnation of the bones themselves are not extensive and whilst there may be a little crepitus upon movement osteophyte formation or lipping of the articular margins does not occur The pits which are made in the bone-ends are filled with gummatous material or fibrous tissue

The tertiary manifestations of syphilis so far as they occur in joints improve rapidly with the administration of potassium iodide and bismuth probably more so than with some of the new intravenous preparations

ARTHRITIS DEFORMANS

Under the title of arthritis deformans is included a variety of joint diseases of which the etiology remains obscure in spite of innumerable investigations. Whilst such diseases are generally regarded as being produced by either toxic or infective agents little success has been achieved in defining exactly what these are. Many claims have been made concerning the true causes and for appropriate treatment but one after another they have failed to stand up to the test. Although this group of joint diseases is so intermingled, it is possible to separate two main classes which differ essentially in their pathology and clinical signs.

RHEUMATOID ARTHRITIS

Rheumatoid arthritis is the first of these It is an acute or subacute polyarticular disease of either toxic or infective origin, which finally becomes chronic The characteristic feature is a thickening of the synovial membrane and the extra-synovial tissues leading to a chronic fibrosis with the production of contractures and deformities. It is a disease which may have either an acute or an insidious onset. Most commonly it develops in young adults of 20 to 30 years of age who previously have been quite healthy but there is a variety of this disease which commences in later periods of life about the age of 55 to 60 Women are more often affected than the opposite sex, in whom it is a rare condition Little or nothing is known as to its causation, but there is a tendency to regard it as being due to metabolic disturbances rather than infection

Pathology.—In the early stages the inflammation is confined to the synovial membrane and periarticular structures the capsule and ligaments of the joint The synovial membrane becomes much thickened and shows hypertrophy of its villi so that the surface appears shaggy Whilst there may be an effusion into the joint, this is usually small in amount Histological examination of the synovia shows a low-grade subacute or chronic inflammation. As the condition progresses the synovial membrane and periarticular structures become more and more fibrotic and the neighbouring muscles atrophied and

contracted. In the early stages the articular cartilages are not involved but in the process of time their edges are invaded by a pannus of granulation tissue which has spread from the inflamed synovial membrane. This granulation tissue gradually erodes and undermines the articular cartilage so that it becomes softened and necrotic. Its cells are slowly absorbed being replaced by fibrous tissue and adhesions are likely to form between the opposing articular surfaces. The underlying bone becomes rarefied and the spaces which are thus formed are filled with fat intermingled with fibrous tissue. In this disease, as compared with osteo-arthritis no osteophyte formation takes place nor except in rare instances, does bony ankylosis result.

Clinical Signs and Symptoms.—The onset as has already been said, may either be acute or insidious but before any joint involvement is noticed or complained of these patients have for some weeks or months before been in indifferent health.

The disease starts most often in the small joints of the hands or feet following which signs appear in the larger joints especially the knees spreading thence to others so that in acute cases the patient must be confined to bed. The degree of pyrexia during the acute stage varies from just above normal up to as high as 103° F or even higher. The patient is obviously ill and very rapidly the general health becomes impaired the pain in the joints preventing any restful sleep at night. The appetite begins to fail, weight is quickly lost and the skin develops a sallow tint. A peculiar odour is associated with such patients probably owing to the fact that their hands and feet are always moist.

The disease tends to exhibit exacerbations and during the intervals the signs of inflammation in the joints settle down, but after each remission the amount of permanent thickening is increased and unless steps have been taken to prevent them deformities are more noticeable. X-ray examination during the active stage shows no bone changes. As the acute signs settle down pain diminishes but the patient is left with various contractures or deformities depending upon how successfully the limbs have been splinted during the active process. An X-ray taken of the joints at this stage will show a decalcification of the ends of the bones with some translucent areas close to the articular surfaces and an absence or diminution of the joint space in consequence of damage to the articular cartilage. When all signs of activity have subsided patients begin to put on weight again and owing to their activity being restricted by the joint changes they are liable to become heavier than before.

Diagnosis.—This is obvious in a typical example of the disease but any polyarthritis of sudden onset in a young male adult in spite of his denials should be very carefully investigated as to the presence of the gonococcus in the urogenital tract, for rheumatoid arthritis is seldom seen in males. A gonococcal polyarthritis in the early stages gives rise to more pain than does the true rheumatoid arthritis and it can also be more crippling in its final end results.

Prognosis.—The prognosis as regards complete recovery without any permanent disability is bad. Rheumatoid arthritis especially in the young adult tends to continue and progress in spite of treatment

though ultimately after many remissions it seems to burn itself out. This may however take several years and the patient will be much crippled from rigidity of many joints if not from actual deformities In spite of the greatest attention whilst the disease is active, some deformities may develop There are few chronic diseases which produce so pathetic a result.

Treatment.—Since it is possible that rheumatoid arthritis is caused by some infection or toxic absorption every endeavour must be made to discover the possible source, for which purpose the teeth, tonsils, genito-urinary tract and alimentary canal require a thorough bacteriological examination with a view to isolating the causative organism The teeth and nasal sinuses need to be X-rayed as they may be infected without any symptoms. In few patients is anything found, but in spite of this every attempt should be made to locate the cause for should any likely organism be isolated an autogenous vaccine may be of value The general experience of vaccines is dis appointing as they have no influence upon the progress of the arthritis. Rest in bed is essential with such splintage as may be necessary to make the patient comfortable and to prevent the development of deformities Considerable relief can be obtained from radiant heat and diathermy When the more active signs have subsided and the pyrexia has completely settled, treatment at a spa such as Droitwich or Bath will sometimes produce a marked improvement in the con dition of the joints and in the general health of the patient, but at the start it is impossible to predict which patient is likely to benefit from these measures One may improve out of all know ledge within a short period, whilst another apparently similar in all respects remains quite stationary Whilst it has to be admitted that treatment appears to have little effect upon the progress of the disease this will certainly settle down sooner or later Often the inflammatory process in all the joints except one subsides whilst this one remains active and painful in spite of everything that is done In such a state relief will follow an arthrodesis of the affected joint. In patients in whom deformities have developed, correction of these is necessary either by gradual splintage or by operative measures.

STILL'S DISEASE

This disease is similar to rheumatoid arthritis It is a poly arthritis of childhood associated with some enlargement of the spleen The onset is acute and associated with pyrexia of a swinging nature The child is seriously ill, loses weight rapidly and develops painful swellings of its joints similar to those seen in rheumatoid arthritis in the adult, but the whole condition is much more severe and pain is a more marked feature Deformities rapidly develop if permitted to do so.

The diagnosis is in doubt at first for the clinical picture is similar to that of acute rheumatism, but enlargement of the spleen and the failure to respond to salicylates leaves very little doubt as to the true nature of the complaint.

Treatment.—This is very unsatisfactory and such a child is commonly left with the majority of its joints both large and small, more or less fixed and rigid from periarticular fibrosis. The only satisfactory method of splintage is to fix the limbs in the correct position in plaster of Paris under an anaesthetic. When this is done the acuteness of the disease will often subside at once and the temperature rapidly fall to a lower level. Such fixation requires to be continued until the general condition is satisfactory even if this takes several months. Afterwards massage radiant heat and active movement will restore a surprising range of movement to joints which may appear at one stage to be completely rigid. The muscular wasting which is a very prominent feature of this disease takes many months before it is overcome.

SPONDYLITIS DEFORMANS

This disease which results in rigidity of the spine is probably one variety of rheumatoid arthritis. It is seen in young adults and starts gradually with pain and stiffness of the lumbar spine. The history given in the early stages is that of stiffness of the back when rising in the morning which stiffness wears off in about half an hour. After some time this persists for longer periods and is associated with backache made worse by any strenuous exercise. Upon examination at this stage very little can be discovered in the way of clinical signs but one feature which is characteristic is limitation of the respiratory excursion. An X ray of the sacro-iliac joints often shows changes in one or both of these joints the joint space being narrowed with the presence of small cavities in the bone in proximity to the articular surfaces. To commence with it is entirely a periarticular fibrosis with which is associated pain and rigidity. The disease spreads up the spine which in time becomes kyphotic and absolutely rigid, being known as the *poker spine.* After a time pain and rigidity may appear in the hip joints and these become gradually stiff. Nothing is known as to its etiology and treatment must aim at the relief of pain and prevention of deformities especially of a kyphosis (see p. 934). The progress of this disease is often very slow and indeed it appears quite often to burn itself out or to become quiescent for prolonged periods. X ray therapy would appear to relieve the patient of pain even if it does not render the disease quiescent.

OSTEO-ARTHRITIS

This disease usually affects one of the larger joints and is characterised by atrophy grooving and eburnation of the articular cartilages associated in the advanced stages with osteophytic formation at their edges. Though as a rule one joint only is the site of this disease there is no reason why others should not be involved.

In contrast to rheumatoid arthritis osteo-arthritis is a degenerative condition. It is liable to develop in the joints of the lower limb especially the knee and hip as the result of the strain and trauma to which they are exposed. It may be described as the result of unfair wear and tear.

Pathology.—The synovial membrane is inflamed and thickened as the result of cell proliferation and an effusion of varying amount, while never great, may be present. Villous hypertrophy of the synovial membrane occurs and as the result of a fatty degeneration taking place in the synovial fringes a condition of lipoma aborescens may form, fatty masses hanging into the joint. The articular cartilage softens then degenerates; fibrillation of the matrix takes place, and at those places where pressure occurs it is worn away and the bone-ends exposed. *The cartilage cells at the edges of the articular surfaces proliferate* and, growing out into the soft tissues, form cartilaginous masses, which undergo ossification and form osteophytes. Some of these may become broken off and form loose bodies (Fig. 590). The bone-ends *first become softened* and then in consequence of friction hardened, eburnated and grooved. The development of these grooves is best seen in the knee joint. *True bony ankylosis as the result of osteo-arthritis never occurs.*

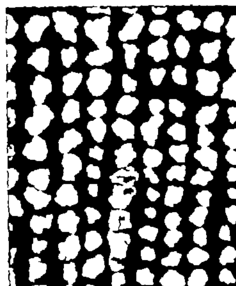


Fig. 590.

Multiple loose bodies removed from a hip joint. These formed a small proportion of the whole.

Intra-articular cartilages or ligaments are gradually destroyed and disappear. Enlargements of various bursæ, *especially of the semi-membranosus* (p. 1224) in communication with the joint are seen at times and should one develop in a knee joint which is affected with osteo-arthritis, it is known as a Baker's cyst.

Clinical Signs and Symptoms.—The patient is generally past middle life and symptoms may develop quite suddenly after some minor injury or reveal themselves more gradually. The patient complains of stiffness associated with a dull ache which is made worse by changes in the weather. Pain is complained of upon making any movement after a period of rest. Creaking in the joint may or may not be noticed, but in the knee it is usually a prominent feature. Upon examination a little swelling may be observed and the temperature compared with the corresponding joint on the other side of the body may be raised. Pressure upon the synovial membrane at its reflection from the edge of the articular cartilage produces tenderness. There is a varying degree of limitation in movement, which produces a fine creaking or crepitus. In some joints, especially the knee, osteophyte formation can be felt. Muscular wasting in the early stages is not obvious, though after a time it may be quite considerable. The symptoms of osteo-arthritis are subject *to exacerbations and during the intervals the patient may be entirely* free from trouble, until some minor injury or twist produces further

symptoms These intervals of freedom become less frequent and of shorter duration as the condition progresses

Whilst many of those patients have septic teeth or are habitually constipated there is no evidence that these conditions cause osteo-arthritis though there is no question but that the absorption of toxins from such a focus will intensify symptoms in the degenerated joint

X ray Examination in early osteo-arthritis shows no bone changes After a time the bones will appear closer together the joint line being diminished as the result of damage to the articular cartilage Later still osteophyte formation with lipping of the edges of the bones is visible The degree of bone changes in such a joint bears no relationship to the symptoms It is possible for a joint with very definite osteophyte formation to give rise to little or no pain whilst another with a nearly clear X-ray may suffer intensely in this respect.

The *treatment* of osteo-arthritis can only be palliative for it is not possible to prevent the joint getting worse Any definite septic focus must receive attention and the bowels require regulating Pain in the affected joint can be relieved in the early stages by radiant heat or diathermy but it must be appreciated that pain is the direct result of limitation in movement and that if the range can be improved great relief will be given to the symptoms In the past such a joint would have been treated with rest a splint and Scott's dressing This only made the patient worse and it is now agreed that mobility of the joint must be improved if relief of symptoms is to be obtained Therefore after the application of radiant heat the joint requires manipulation if possible without an anaesthetic a little further improvement being obtained upon each occasion. If this is of no value one manipulation under full anaesthesia followed by physical treatment and active use may obtain the desired result

In those joints which are too much damaged for such means to be adopted relief can be obtained with any certainty only by fixation of the joint to prohibit any subsequent movement Provided the patient is in a sufficiently good general condition to stand the operation, such a procedure as arthrodesis gives great satisfaction In the case of the hip joint some form of arthroplasty is often necessary in those patients who have both hip joints affected.

Osteo arthritis in Special Joints

The hip is quite commonly the site of an osteo-arthritis which in old people is known as *morbus coxæ senilis* (Fig 591) Osteo-arthritis of this joint whilst commonly seen in later life may develop at any age In the young it is apt to follow an unreduced separation of the femoral epiphysis or too forcible attempts at its reduction It follows an untreated pseudocoxalgia in which the femoral head has become misshapen, sometimes within a period of a few years It may occur about the age of 30 years in an unreduced congenital subluxation of the hip the arthritis developing between the femoral head and the acetabulum. In patients of about 50 years of age an osteo-arthritis will sometimes occur in this joint without any definite reason. They

may give a history of an accident many years previously and it is quite often found that in their younger days they were in the habit of taking excessive exercise during which this joint might have sustained injury without symptoms developing at the time

Pathology —The synovial membrane is very much hypertrophied and the capsule of the joint thickened and fibrosed. The head of the femur is flattened like a mushroom, as if its substance had melted and then hardened again at the margin and shows a large amount of osteophyte formation. The head in an old-standing osteo-arthritis of the hip may be found partly subluxated out of the acetabulum, the upper and back lips of which have melted in the same way as the femoral head and then ossified again. The articular cartilage is almost completely destroyed and the two bone surfaces are composed of sclerotic bone



Fig. 891

Advanced osteo-arthritis of the hip joint in an elderly patient showing enormous overgrowth of bone and commencing ankylosis at the upper part of the joint.

Clinical History —The patient complains of stiffness upon rising from a chair of the leg becoming shorter or of the hip bone sticking out whilst difficulty in getting the shoe on to the foot of the affected limb is sometimes noticed. Pain varies enormously It may occasionally be so severe that life is miserable by day and at night sleep is impossible but whilst pain is always present to some extent it is usually more of a constant dull ache Pain along the course of the sciatic nerve is occasionally complained of rather than in the joint itself Often by the time advice is sought the hip is fixed in adduction, flexion and eversion, so that sometimes the patient complains of pain in the lumbar region and not in the joint. Such pain is due to muscular strain in constantly maintaining a lumbar lordosis to compensate for the fixed flexion deformity of the hip and the patient often has no idea that there is little or no movement in that joint Marked wasting of the thigh muscles is a prominent feature even in the early stages of this condition An X-ray shows the joint line either diminished or absent as the result of erosion of the cartilage whilst the head has become flattened, irregular in outline and often subluxated backwards and upwards Large masses of osteophyte formation are usual upon the head of the femur and also on the lips of the acetabulum

Prognosis —Many patients after a time cease to have much in the way of symptoms and learn to adjust their mode of life to the condition

which exists in the hip joint but in others the pain becomes worse and drastic measures may have to be employed to relieve it

Treatment consists in such measures as radiant heat ionisation diathermy and massage which give the patient considerable relief if only for a limited period Spa treatment does not produce as much improvement as it does in rheumatoid arthritis Manipulation of the hip joint under an anæsthetic often gives temporary relief The explanation of this is that the pain is due to fibrosis and contracture of the capsule rather than to formation of osteophytes and by manipulation the capsule and ligaments are stretched physical treat ment afterwards preventing them, at any rate for a time becoming contracted again. Manipulation is also a therapeutic measure of value as by this means the bad position into which the joint may have got can to some extent be corrected Under an anæsthetic the thigh is first abducted the adductor muscles (if these are contracted) being divided with a tenotome so as to obtain as wide abduction as possible The joint is then fixed in plaster in slight abduction In this the patient can walk in a few days with freedom from pain for it is not weight bearing but movement in osteo-arthritis which gives rise to symptoms Such a plaster may be worn for a period of three months and this fixation is often a means of relieving the patient from pain and thus enabling him to sleep in peace Should all these methods of treatment fail, surgical means will have to be employed. While all kinds of operations have been devised and employed for the treatment of a painful osteo-arthritic hip there are only three methods which can be advocated with any certainty of success and that is the operation of arthrodesis some form of arthroplasty or else an intertrochanteric osteotomy of the McMurray type which corrects the deformity of the limb and at the same time alters the thrust upon the joint The particular method which is used for any patient must be decided upon after consideration of many factors such as the nature of the work done the age and general condition of the patient and his ability to co-operate in a rather prolonged convalescence The McMurray operation has the great merit that it is associated with little shock to the patient a factor of great importance in the more aged The relief of pain is immediate and after about three months the patient can be permitted to walk in a close-fitting plaster which is retained in all for about three months. The position in which the hip is fixed must be one of 30 degrees flexion and slight abduction

The Knee

This joint is affected with osteo-arthritis more commonly than any other Women are peculiarly susceptible to degenerative changes of this nature in this joint They complain of stiffness, pain and tenderness on movement after resting Their knees are liable to give way and difficulty is experienced in coming down stairs rather than in ascending them. After any severe injury such as a fracture of any of the bones forming the knee joint osteo-arthritis is liable to develop though the onset of symptoms may be delayed for many years. In the common

variety in women the X ray may reveal few changes while at times a joint which has only just begun to give symptoms will be found to show marked lipping and osteophyte formation in the film

Treatment—Rest with a back splint is definitely harmful in the osteo-arthritic knee of the middle-aged woman Movement which is limited, especially as regards flexion, must be increased. For this purpose heat in some form must be employed and then the masseuse is instructed gradually to increase the range by active and passive movements The patient must be encouraged to do exercises to maintain movement afterwards If such methods do not achieve the desired end, manipulation under an anæsthetic will often succeed In some knees the removal of osteophytes and even both cartilages which are so swollen and thickened that they prevent full extension of the joint will result in great permanent improvement in function When osteo-arthritis follows upon some severe injury these measures may fail to give relief Pain is too severe and the knee may have developed a fixed flexion which prevents the patient bearing weight upon it. Under these conditions an arthrodesis is necessary to relieve pain and provide a limb capable of bearing weight. The only disadvantages of a stiff knee are that the patient is unable to kneel, and the limb is apt to be a nuisance in a bus or train but the relief of pain and the improvement in the general condition more than compensate for these disadvantages In a few patients where the arthritic changes are principally confined to the patello femoral joint surfaces removal of the patella will cure the symptoms and avoid a stiff knee

The Ankle

Osteo-arthritis is wont to develop in this joint after a Pott s fracture which has not been completely reduced and even sometimes after an apparently perfect reduction It is a very crippling disability for the patient is unable to walk on account of constant pain and an arthrodesis is called for as the only means of relieving the condition. Arthrodesis of the ankle although it abolishes the movement of this joint handicaps the patient very little and an active life is perfectly possible as also is hard manual work

The Shoulder

In this joint osteo arthritis is uncommon but is often diagnosed as neuritis since the patient complains of pain down the front and outer surfaces of the arm. Examination of the shoulder joint under such circumstances reveals limitation of movement in all directions, internal rotation being restricted more than any other movement. X ray examination shows little if any osteophyte formation.

Treatment consists in manipulation under an anæsthetic the arm being subsequently fixed on an abduction splint at an angle of 90 degrees to the trunk. Physical treatment with exercises to maintain the movement obtained by manipulation is employed and the abduction splint is worn until the patient can voluntarily hold the arm abducted at a right angle and can lower and raise it from the trunk to this position.

LOOSE BODIES IN JOINTS

Loose bodies occur in several joints but it is the knee in which they are most often encountered A single one may be found or as many as two or three dozen (Figs. 592 and 593) They may be either entirely free to wander about within the cavity of the joint or shut off in synovial pouches Sometimes they are attached by a pedicle to the synovial membrane Several varieties are found

1 **Cartilaginous Loose Bodies,** which originate from cartilaginous nodules in the synovial membrane the so-called synovial chondromata To commence with such loose bodies are pedunculated but after a time they may become free and then give rise to symptoms They have a smooth cartilaginous exterior with a nucleus of ossified



FIG. 592
A single loose body in the knee joint.



FIG. 593
Multiple loose bodies in the knee joint.

bone in the centre and gradually increase in size deriving their nourishment from the synovial fluid Such a loose body may develop in a joint which is otherwise normal, but if they are multiple an osteo-arthritis is commonly present (Fig 594)

2 **Ecchondroses** may be broken off and become free in the joint forming irregularly shaped loose bodies

3 A portion of the articular cartilage may be torn off as the result of violence and form a loose body This is seen in the knee joint in the condition known as **osteochondritis dissecans.** The fragment is separated from the lower end of the femur and leaves a hole at the place whence it came Such a loose body is composed of articular cartilage covering a portion of bone the other surface of which is smoothed over by a layer of fibrous tissue

4 **Fibrinous Loose Bodies** occur in joints after a hæmarthrosis or in a tuberculous arthritis In the latter condition there may be many hundreds of them. They are flattened and elongated, and from their appearance are called melon-seed bodies.

The *symptoms* of a loose body are produced by it becoming caught between the articular surfaces The joint is locked for a moment with acute pain, the loose body then slips out of the way and *freedom of movement is restored to the joint. After the first attack* a synovitis results, but this becomes less frequent and of minor severity after each attack of locking The patient can often isolate the loose body especially in the knee joint Owing to its characteristic habit of wandering from one part of the joint to another such a body is sometimes known as Gelenkmaus " or joint mice

The *diagnosis* is usually confirmed by an X ray as these typical loose bodies contain an osseous nucleus In the knee the diagnosis between a loose body and a torn semilunar cartilage is not always easy unless the former appears in the subcrureal pouch, when it can be felt

The history is all important as locking with a loose body is momentary whilst in the case of a cartilage this will remain out of position until it is reduced either by the patient or his doctor



Fig 594
Two loose bodies in the elbow

Treatment consists in removal through a small incision In the knee if the loose body wanders about very freely after the joint has been opened it may get lost in such a case the cavity should be flushed out with sterile saline when the loose body will often float out of the incision and obviate the necessity of a wide exposure

The *prognosis* with a single loose body if no arthritic changes are present, is good, the joint being capable of full activity If an osteo-arthritis is present the removal of the loose bodies will improve the patient's function but the underlying arthritis may continue to cause trouble though often it ceases to do so when the loose body has been removed

When resulting from injury it requires removal but the joint takes longer to recover than in other cases

HÆMOPHILIAC JOINTS

In the condition known as hæmophilia any minor injury or twist is likely to result in a sudden effusion of blood into a joint cavity The knee is most often affected in this way The joint becomes suddenly distended hot and painful for no very obvious reason After the first attack it may recover its normal function but further attacks are likely to occur and in a very short time the synovial membrane becomes permanently thickened and movements restricted With repeated attacks of hæmorrhage adhesions develop and ultimately a chronic arthritis with destruction of the articular surfaces follows the joint becoming so lax that its stability is impaired

Diagnosis —At the first attack this may be difficult but the painful and sudden distension of the joint without any serious trauma

should always give rise to a suspicion of the true nature of the condition also if careful enquiry is made into the history some information of previous hæmophilia in the family can be obtained.

Treatment consists in absolute rest in bed with a pressure pad and bandages to help the absorption of fluid Later gentle massage and exercises to keep the muscles in condition are desirable Under no circumstances must the joint be aspirated as this is likely to start the hæmorrhage again

The *prognosis* as regards the affected joint is not very good in consequence of the disorganisation which ultimately may occur as the result of repeated hæmorrhages A splint of some kind is necessary to enable the patient to get about.

NEUROPATHIC ARTHROPATHIES

Charcot's Joints

A neuropathic arthritis is a condition in which the joint undergoes certain degenerative changes the patient being the subject of some disease of the nervous system It is most commonly seen in tabes dorsalis when such an affection is known as a Charcot's joint. A similar type of arthritis occurs in association with syringomyelia, and apart from any other sign if it is present in the upper limb the underlying disease is probably this latter



Fig 595
Charcot's disease of the ankle joint.

Two distinct clinical types are met with —

1 The hypertrophic, in which the joint becomes disorganised and enormous masses of new bone are formed around the edges of the articular surfaces. Bony masses may also form in the synovial membrane or in tendons as for example in that of the quadriceps when the knee is affected.

2 The atrophic type which is not as common as the previous variety In it the joint becomes distended with fluid there is some thickening of the synovial membrane and the bone-ends become rarefied and absorbed (Fig 595)

Nothing is known of the pathology of this condition except that it occurs in tabes with degenerative changes in the posterolateral columns of the spinal cord but why in one patient the hypertrophic form is developed and in another the atrophic is unknown The knee is most often involved, though any joint may show these changes. Occasionally more than one joint may be affected. In both varieties the onset may be quite sudden without any previous history

Clinical History.—The patient either seeks advice because the affected joint is unstable or may complain of lightning pains in the limb without having noticed any pain in the joint This is swollen,

with a varying amount of effusion which in the atrophic type is more marked than in the hypertrophic. Abnormal mobility is present especially in the atrophic type in which owing to softening of the ligaments the bones can be moved on each other in all directions. In the hypertrophic variety much creaking may be felt and large masses of bone are palpable in and around the joint Other signs of tabes are usually present such as an Argyll Robertson pupil, loss of knee-jerks and ataxia, but in a few patients the development of the joint condition is the first sign of any lesion of the central nervous system

An X-ray examination will reveal the nature of the joint disorder, if this has not already been decided by a clinical examination

The *prognosis* varies greatly with each individual. In one the condition will remain unchanged often for a year or two whilst in another especially if the lesion is of the atrophic type the absorption of bone may take place very rapidly and the stability of the joint become impaired within a short interval.

Treatment can aim only at providing some form of splint which will enable the patient to bear weight on the limb by rendering the joint more stable Great care must be taken to avoid pressure sores whilst using this splint for the sensation of the limb is impaired. Any attempt to render the joint stable by operation is undesirable on account of the danger of its becoming infected Very rarely amputation may be called for but except in selected cases this should be avoided owing to the danger of the flaps not healing properly

As has already been pointed out a similar articular condition may develop in syringomyelia, a disease in which there is a gliomatous degeneration of the spinal cord It occurs generally in the cervico-dorsal segment and is characterised by loss of the sensations of pain, heat and cold together with muscular atrophy Owing to the site of the cord lesion an arthropathy in syringomyelia is most commonly seen in the upper limb The atrophic form is nearly always found in this disease The patients are usually much younger than those who develop the typical Charcot's joint of the lower limb

Treatment is unsatisfactory and the wearing of any apparatus is especially difficult, as the danger of trophic ulcers is very great Joints of this nature may develop in other nervous diseases such as myelitis disseminated sclerosis anterior poliomyelitis or spina bifida but they are so rare as to require mention only

Hysterical Joints

These joints are very much more common than is sometimes realised No age is immune even very young children being liable especially after a minor injury and often the most unlikely people develop troubles of this nature The characteristic clinical feature of all of them is that the affected limb and joint are held in a grossly exaggerated position such as is seldom seen in any organic disease Great pain is complained of and the joint concerned is held rigidly fixed Any attempt to move the joint however slight increases the pain of which the patient complains and such endeavour is firmly resisted Clinical

examination will fail to reveal any signs of disease in the joint During sleep the limb may be seen to lie in a normal position and under an anaesthetic may be moved fully in every direction The greatest care needs to be taken before a diagnosis of hysteria is made for to treat a joint with an organic disease as hysterical would be a disaster

Treatment is always very difficult In young children, when it follows some minor trauma if no notice is taken and the child is sent to school and allowed to play games the condition clears up But in adults the problem is quite a different one The patients are usually introspective and surrounded by troublesome relations who in their attempts to be kind often make it harder to obtain a cure The patients may show every eagerness to be cured and yet at the same time resist treatment They should be removed from proximity to relations and friends and placed under the care of a psycho-analyst Unfortunately even if he is able to cure the particular condition from which they are suffering there is a great liability for some other manifestation of hysteria to develop perhaps months or years later should a favourable emotional state arise

E P BROCKMAN

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E P BROCKMAN

CHAPTER XLIX

DEFORMITIES

A DEFORMITY may be defined as a morbid alteration in the form of a part or organ of the body This does not mean that there is necessarily any visible alteration in the outline of the part but the morbid alteration is such that its presence is revealed by a certain loss of function Modern orthopædics are directed towards the study of the form and function of the human frame their attack is trained on those affections which deform the architecture or arrest the balanced mechanism of man s body Injuries of bones, joints, muscles nerves and soft structures which result in loss of form or function are thus their legitimate objective



FIG. 596

Congenital deformity of the hand.

Prevention is always better than cure and if the principles and practice of preventive orthopædics were more liberally applied to-day many of the more severe degrees of flat foot, scoli osis and like deformities would never occur It must be realised that many deformities are the end result of pos tural or static anomalies acquired as a consequence of bad habit rather than the result of a definite pathological lesion. An elaborate mechanism is required to control and maintain the upright position of the body When this mechanism fails, the body processes are upset and many obscure and distressing maladies may result In such cases the body posture must be corrected.

Congenital deformities are either primary or secondary the latter differing in no way from similar conditions in post natal life. The primary congenital error is due to some defect in the fertilised ovum (Fig 596) while the secondary error arises from some such mechanical cause as the continued fixation of a part in such a position as to give rise to structural moulding A congenital deformity is not necessarily obvious at birth The tendency to congenital dislocation of the hip may be present but the actual dislocation may be delayed until the child attempts to walk

Apart from congenital conditions deformities fall into one of five groups —

Affections of bones.
Affections of joints
Affections of muscles tendons and other soft structures
Affections of the nervous system
Static deformities

In the affections of the nervous system are seen the mechanical effects of attempting to support weight or carry out function with a more or less flail-like part to which are added the results of trophic wasting and retardation of growth of the part In spastic paralysis the deformation is largely due to the overpowering of weaker by stronger muscles.

In the production of deformity the earliest factor is usually gravity Thereafter there is shortening or contracture of muscles and soft tissues and ultimately deformity of bone from alteration of pressure or of growth It is clear therefore that the subject of deformity is no narrow speciality but a most important branch of surgical science worthy of the closest study

DEFORMITIES OF THE UPPER EXTREMITY

Sprengel's Shoulder

Congenital elevation of the scapula was first described by Sprengel The deformity is characterised by an abnormally high and permanent elevation of the shoulder girdle It is frequently associated with other deformities, such as absence of vertebræ, fusion of ribs or cervical rib

The shoulder girdle first appears as a cervical appendage and gradually descends by the end of the third month of intra-uterine life to the level of the upper part of the thorax. The failure of the normal descent is the cause of this congenital deformity but the reason for this failure has not yet been properly explained.

The condition is often bilateral, and the scapulæ are fixed in an abnormal manner to the vertebral column, either by a cartilaginous bridge or by a band of stout fibrous tissue. The muscles which elevate the shoulder girdle are usually deficient or absent

Clinical Features —The scapula may be as much as 4 in. higher than normal and rotated so that its lower angle is nearer the vertebral column. Abduction of the arm is restricted in many cases since the usual degree of scapular movement is absent The shoulders are asymmetrical and the neck appears short Torticollis and scoliosis are present when the case is unilateral. The X ray appearances are characteristic the unduly high situation and small size of the scapula being the principal features.

Treatment —Where the scapula is anchored to the spine by means of a bone or fibrous tissue bridge the latter should be removed and any shortened muscles tenotomised at the same time In some cases

terminal phalanges is checked by what appears to be a congenital shortening of the soft parts on the flexor side In some cases several fingers may be similarly affected

In infancy manipulation and stretching may overcome the deformity by lengthening the contracted tissues In later life the prospect of cure is slight and there is a tendency to further contraction which may be corrected by shortening the proximal phalanx.

Trigger Finger

This is a condition in which some obstacle to full movement is present in the affected finger so that the movement can only be completed by very considerable effort on the part of the patient or with assistance When an attempt is made to extend the fingers from the fully flexed position the affected finger lags behind in the flexed position, but jerks into extension when the obstruction has been overcome When passively moved, slight resistance is encountered until a certain point is reached after which movement is free

It usually affects the middle finger of the right hand particularly in women. The obstruction is caused by abnormal narrowing of the tendon sheath from thickening of its wall (tenovaginitis stenosans) or contraction of the volar accessory ligament

The most satisfactory method of treatment is to expose the tendon sheath and incise it longitudinally leaving it unsutured.

Deformities of the Elbow

Cubitus valgus is the name given to the deformity in which the forearm is abnormally abducted at the elbow joint while in **cubitus varus** the inclination is in the other direction Both of these conditions may frequently be seen as congenital deformities They are however much more common as a result of a supracondylar fracture of the humerus which has united without being properly reduced. They are usually associated with a considerable degree of laxity of the ligaments of the elbow especially in a third type of case which is associated with rickets

Normally when the supinated forearm is extended there is an angle of 170 degrees opening outward. This is called the "carrying" angle because the hand is thus held at some distance from the body while the arm is in contact with the trunk. The angle is not apparent when the forearm is pronated There is thus a certain degree of cubitus valgus which is normal Among women, however this normal angle may be exaggerated to produce a deformity In cases of extreme deformity the ulnar nerve may be affected and partially paralysed. Each of the deformities may be treated by osteotomy of the humerus just above the articulation after the method used to correct deformities of a similar nature at the knee After osteotomy the deformity is corrected and the arm and thorax fixed in a plaster case In most cases, however the deformity is so slight and the function of the arm so little limited that it is unnecessary to carry out any treatment.

DEFORMITIES OF THE SPINE

Scoliosis

Scoliosis is a distortion of the spine characterised by rotation and lateral bending In addition to the permanent deviation of one or more vertebræ from the midline of the body there are alterations in the relative positions of the ribs and pelvis and adaptive changes in muscles and ligaments The condition occurs chiefly amongst the hospital classes and is rarely seen in private practice It is more commonly observed in girls—perhaps because they are more conscious of slight degrees of deformity and consequently complain of them

Classification—The curvature may be spoken of as right or left according to the side of the convexity It is also named according to the anatomical region involved, while occasionally curves are referred to as being primary or secondary but it is sometimes impossible to decide which is which. A single curve is also occasionally called a C-curve and a double curve an S-curve



Fig. 600
Adolescent scoliosis.

There are two types of scoliosis (1) functional or postural and (2) structural rigid or fixed

The distinction between the two types is quite definite

1 **Functional Scoliosis.**—A functional curve is one which (1) can usually be corrected voluntarily (2) is common in children of school age and (3) is caused by faulty posture in occupation, especially during the period of growth

The extent of the deformity is within the range of normal spine movement but the attitude is so frequently adopted that it becomes habitual or perpetual. Structural changes occur only in late stages. They are compensatory and essentially similar to the secondary changes which follow the structural type When definite changes occur in the tissues in the course of a functional scoliosis the case may then be regarded as having gone over to the rigid or structural type This occurs in a small proportion of cases

The typical features of a total right scoliosis are as follows (Fig 600) —

1 A general curve concave to the left
2. Elevation of the left shoulder
3 Backward displacement of the right shoulder girdle and forward displacement of the left
4 Undue prominence of the right side of the back when the patient bends forwards
5 Exaggeration of the hollow at the waist line on the right side

Functional scoliosis may be associated with other evidences of muscular weakness such as round shoulders lax abdomen and weak feet

2 **Structural Scoliosis.**—This organic type presents a completely different picture as the trunk is grossly misshapen The patient is unable to correct the deformity voluntarily as the distortion is due to structural alterations in the vertebræ ribs ligaments and muscles, and is consequently permanent. The degree varies from a gentle convexity to a sharp angulation known as razor back. The vertebral column is curved in the anteroposterior plane and, since it is a flexible weight bearing rod it cannot yield in another plane without its constituents simultaneously undergoing rotation. The vertebræ turn away from the area of maximum stress on the concave side of the lateral curve and are rotated towards the side of the convexity

Etiology—In many of the cases the cause of the deformity is self-evident as in the types due to congenital malformation, torticollis short legs or other pathological affections of the body In others, however it is by no means easy to assign a cause to it. Faulty attitudes at school or at play may be important factors in the etiology but it is probable that even in these cases there is some error in the neuromuscular mechanism, resulting in unilateral weakness and subsequent deformity This is especially so in the functional type which makes its first appearance at the school age of life the period when the strain of mental work first begins to be appreciated

Pathology—**Changes in the Vertebræ.**—The vertebræ at the apex of the curve are compressed to a wedge-shape and are called the wedge or apical vertebræ The bones above and below the apical vertebræ also show characteristic distortions in that they are twisted on their vertical axes to form the so-called lozenge-shaped vertebræ. The spinous processes are deflected towards the convexity of the lateral curve The intervertebral discs are compressed and squeezed out beyond the edges of the body The ligaments on the side of the concavity are dense and thick while on the convex side of the curve they are thin and lack a definite lateral border The muscles show evidence of deformity in that on the convex side they are atrophied while on the concave side they are hypertrophied.

Changes in the Thorax.—The thorax is displaced towards the side of the convexity and distorted, undergoing a twist in a direction opposite to that of the spine so that its horizontal diagonal is altered. Frequently the development of the internal organs is prevented and their functional activity seriously impeded so that both the pleural and abdominal cavities are deformed.

General Symptoms—In the earlier stages of this condition the patients are comparatively healthy and suffer little inconvenience. They are able to attend school, and their physical development is almost equal to that of a normal child Usually the mother consults the doctor owing to some outstanding feature in the child, such as a high shoulder high hip prominent shoulder blade or a slant in the waist line Usually the deformity is well established before treatment is sought Pain is seldom the complaint under the age of 10 years It

usually takes the form of a mild backache increasing on exertion At a later stage there is pain as a result of pressure of the lower ribs against the iliac crest Occasionally too referred or root pains are experienced in the limbs chest or abdomen. *Gastro-intestinal disturbances* may occur from pressure on the abdominal organs while similar pressure on the chest causes dyspnœa and tachycardia especially on exertion Later in life painful secondary arthritis of the spine arises

Clinical Examination of the Thoracic Organic Curve—1 *The curve is usually to the right and some or all of the thoracic vertebræ are involved.*

2 There are compensatory curves in the opposite direction above and below the primary one

3 The right shoulder is higher than the left and the right scapula so elevated and rotated that its inferior angle projects and is situated much farther away from the midline than on the left side

4 The ribs on the right side are prominent projecting backwards and their angulation is decidedly increased Their downward inclination is greater and the intercostal spaces wider than normal

5. The right arm hangs away from the body and is farther from the midline than the left

6 A transverse furrow or crease at the junction of the chest and lumbar region on the left side is noted while on the right side the normal contour of the waist-line is either entirely obliterated or considerably filled up

7 When the patient bends forward the posterior projection of the right side—the rib hump —is rendered more prominent, as is the asymmetry of the back.

In an anteroposterior radiogram where the curve is limited to the thoracic region the shape of the spine can be aptly likened to that of a question mark. The two vertebræ at the apex of the curve are wedge-shaped their bases to the right The abnormal position of the spinous processes and the appearance presented by the articular facets are evidence of the rotation of the vertebral bodies

Diagnosis—A lateral curvature occurring before puberty and not associated with pain suggests a diagnosis of scoliosis When scoliosis is present it must be decided whether it is (*a*) postural or (*b*) structural and the exact type of curve defined The cause should be ascertained if possible as this may have some bearing on the treatment

The condition may be differentiated from Pott's disease which presents pain on movement and loss of spinal mobility with impairment of general health and from arthritis deformans which usually occurs in adults and is characterised by pain and stiffness a diminution or loss of the lumbar convexity and a gradual curvature showing little or no rotation

Treatment—*A* **Functional or Postural Scoliosis.**—As this type is due in great measure to faulty posture the treatment should be directed to the removal of the cause In this respect the effects of improperly adjusted clothing, which pulls unevenly on the shoulders, of ill-designed school furniture of bad habits of carrying or reading in poor attitudes and of defects of sight must all be carefully considered and their

importance assessed Where the child is weak and pale the diet may be found to require adjustment fatigue avoided and an adequate amount of fresh air and sleep prescribed.

The corrective part of the treatment consists in the employment of gymnastic exercises which will develop the muscles of the body Particular attention is paid to re-education of the special muscle groups which hold the body erect and in its normal symmetrical attitude The type vigour and duration of the exercises are regulated according to the patient's ability to complete them without fatigue Where the patient tends to return to the faulty position between the exercises it is advisable to fit a light temporary corset

B Structural Scoliosis.—The treatment of this type is a complicated problem since there are serious and advanced alterations in the shape and internal structure of the various parts of the trunk. An attempt is made to stretch the shortened and contracted tissues to re-establish or increase the spinal mobility and to overcome the malposition and deformity of the vertebræ.



Fig. 601
Type of plaster jacket for the treatment of scoliosis

This may be carried out under one of four heads, or combinations of them (1) gymnastics (2) corrective jackets (3) gymnastics plus retention corsets and (4) operative treatment.

1 *Gymnastic Exercises* —Exercises are useful only in the mildest types of structural scoliosis. If they do not cause any improvement, either the exercises are not being properly performed, or what is much more likely the spinal error is too exaggerated Exercises increase the strength of the muscles and the mobility of the spine improve posture and have a wholesome effect upon the patient's general condition Progressive improvement is the only criterion of efficient gymnastic treatment

2 *Corrective Jackets* —Before fitting a corrective jacket the spine should be mobilised by some method of passive stretching Lovett uses a special table on which the patient lies face downwards with the legs hanging over the end. Three canvas straps are fitted to the table and work through pulleys. One strap circles the shoulder girdle and one the pelvis these being respectively above and below the primary curve When pulled on, they tend to straighten out the spine A third strap surrounds the chest at or about the level of the deformity and traction on it in the opposite direction enhances the corrective force The lateral deviation may benefit but the manipulation has little effect on the rotation of the vertebræ When the maximum correction has been obtained by this method a jacket of the Abbott or the M'Crae Aitken type is fitted (Fig 601)

The features of the Abbott method of forcible correction are as follows The patient is placed in a position of flexion on a special frame The pelvis and shoulders are fixed by canvas bands and corrective pressure exerted on the deformity by a further canvas

band as on the Lovett table A jacket is then applied in this position of flexion and is longer on the side of the concavity Large windows are cut over the flattened ribs both behind and in front and small oblong gutters over the rib humps Through these latter openings pads of felt are inserted to exert pressure on the bulging part of the ribs Additional pads are inserted about a week after the application of the jacket and thereafter at weekly intervals up to the limit of the patient s resistance During treatment the results are judged by the clinical appearance of the back and chest and especially by the X ray appearance of the spine

3 *Gymnastics plus Retention Corsets*—As soon as the scoliosis has been corrected the plaster jacket should be discarded and replaced by a removable one Gymnastic treatment should also be begun at this stage The jacket is either a quadrilateral iron type with pelvic and chest bands or a removable turn buckle pattern

The turn buckle jacket is of celluloid made over a plaster cast of the patient s torso It is divided into upper and lower halves both of which are open in front to allow of their application. The jacket is strengthened with steel bands and the turn buckle applied together with the necessary straps Gradual tightening of the turn buckle straightens out the spinal curvature by slow degrees

4 *Operative Treatment*—The great majority of cases of rigid scoliosis either cannot be completely corrected or tend to recur whenever treatment is stopped. In these spinal fusion is indicated to prevent the deformity increasing The operation is particularly recommended in patients who on reaching adult life seem doomed to wear jackets or some other form of heavy apparatus all their lives

When the maximum amount of correction has been obtained by passive stretching and by plaster jacket correction a fusion operation is carried out to prevent relapse A good method of correction is by means of a fishing net or hammock A hole is made for the arm to go through and the patient lies on his concave side so that gravity tends to correct the deformity The operation may be of either the Hibbs or Albee type. Ordinarily a modification of Albee s method is used, and three or four grafts applied along the spinous processes and in contact with the laminæ and transverse processes on the concave side of the curve the ends being embedded between the split segments of the upper and lower spinous processes After operation the patient is placed on a Whitman frame for about six months by which time ossification should be complete and the vertebræ securely ankylosed Thereafter a light plaster-of Paris jacket is applied and the back supported for at least another six months If no relapse has occurred at the end of this time the patient is given a corset which is worn day and night at first later left off during the night then for a few hours during the day and finally altogether During this period of treatment gymnastic exercises are unnecessary

Kyphosis

Adolescent Kyphosis.—The normal anteroposterior curve of the spine is subject to many variations so that it is difficult to say when

a borderline has been crossed and a pathological kyphosis produced The commonest form of adolescent kyphosis is the type known as round shoulders (Fig 602) While the error may become apparent any time after the erect position is assumed the majority of cases occur at adolescence and considerable interest centres round the question of their etiology Some may be due to congenital factors, others to conditions associated with muscular weakness and consequent bad posture others again to rickets or vertebral epiphysitis

Vertebral epiphysitis was described by Scheuermann in 1921 when he found definite radiographic alterations consisting of irregularity and deformity of the epiphyseal discs Scheuermann considered the process analagous to that of juvenile osteochondritis X rays demonstrated an epiphyseal irregularity at the anterior edges of the bodies together with a definite wedge-shaped deformity of the somewhat atrophied vertebral bodies The intervertebral space was lost having become clouded and mottled (see p 935)



Fig 602
Adolescent kyphosis

Clinical Features—Adolescent round back is commonest between the ages of 12 and 18 years, and usually affects the thoracic region. Symptoms are remarkably few indeed the only one of note is the deformity Occasionally however there may be vague backache or a history of easily induced fatigue

In the type due to epiphysitis there may be pain local and referred to the legs and the spinous processes of the vertebræ may be tender

In the postural or muscular type the child lacks vigour and is usually much below the average in muscular development His movements and gait are clumsy and there may be other evidences of defective muscular tone such as prominent belly and flat foot The attitude is characteristic the head is flexed the thoracic curvature and the lumbar lordosis increased the shoulders droop the chest is narrow and flat and the scapulæ are prominent If it is possible to undo the deformity such a case is referred to as of the *flexible* type In many cases however the attitude is fixed and permanent—the so-called *resistant* type

Treatment—*A* Postural Type.—When the deformity can be reduced either actively or passively treatment should take the form of mild stretching and of supervised exercises designed to develop the spinal and abdominal muscles. Where the condition is resistant, thorough mobilisation of the vertebral column by stretching is necessary This is most efficiently accomplished by stretching the shoulders over a padded roll The forcing back of the scapulæ tends to stretch the contracted soft tissues When the spine is flexible gymnastic exercises are employed A certain number of patients will

require a corset or brace until their muscles have developed sufficiently to maintain the improvement

B **Organic Type.**—In this form the spinal error if untreated is progressive Treatment follows similar lines to that of early tuberculosis of the spine *i.e* absolute recumbency on a Whitman frame with traction applied to the head or legs or both After three months of recumbency the child is allowed up *but the spine should still be* protected by a plaster-of Paris jacket

Adult Round Back (Senile Kyphosis)—Increasing spinal deformity commonly accompanies advancing years and is associated with *a variety of pathological changes in the spinal components* Many of these cases have hitherto been classed as osteo-arthritic and certainly the vertebral changes often bear a close resemblance to this condition Others are ascribed to occupation the demands of which have led to certain adaptive changes rendered permanent as the years go on The bowed back of old age has been regarded as almost physiological, and few attempts have been made to separate or classify the varying pathological types

Various groups may nevertheless be recognised —

1 True Senile Kyphosis, in which the spinal curvature is the characteristic process the intervertebral discs being for the most part well preserved and the vertebral bodies practically normal.

2. Spondylosis Deformans in which there is usually some curvature but the intervertebral discs are degenerated and the vertebral bodies profoundly altered while there is a marked tendency to the production of marginal osteophytes and ankylosis These changes have hitherto labelled such a spinal condition as osteo-arthritis or spondylitis *deformans*

3 Senile Osteoporosis —Here there is a slighter increase in the spinal curvature The main incidence of the degenerative changes has fallen on the vertebral bodies the discs being relatively normal at least in the early phases of the disease

4 Von Bechterew s Disease —Here the main change is in the small intervertebral joints with resulting ankylosis of the whole column.

Diagnosis —In addition to distinguishing between the different members of this series senile kyphosis must be distinguished from those diseases of the vertebral body which result in deformity The most important of these are tuberculosis—rare at this age—and Paget s disease

Senile kyphosis is seldom amenable to treatment but if pain is a prominent feature the use of a spinal brace or a chin support may give some measure of relief by preventing the constant drag produced by the weight of the head

Lordosis

This is the name given to an abnormal degree of the normal anterior curvature of the spine *i e where there is an undue anterior convexity* It is almost invariably compensatory in nature and is

found in association with a kyphosis at another part of the spine, as in tuberculosis with a marked posterior gibbus It occurs above and below the diseased area to correct in part the forward flexion caused by the gibbus In stout females there is usually a considerable degree of lordosis in the lumbar region, as there is also in those who are pregnant or have abdominal tumours of any size There are instances however where the condition is not compensatory—in such affections as rickets spondylolisthesis and rarely in infantile paralysis. It is sometimes seen in people whose occupations necessitate the carrying of heavy loads suspended from the shoulders as in street hawkers with a heavy tray of goods

Treatment.—The treatment of these abnormal anterior convexities is the treatment of the underlying cause or its elimination. Rickety lordosis demands general treatment of the disease itself—local support for the weakened musculature and massage exercises and electricity to increase muscular tone

DEFORMITIES OF THE LOWER EXTREMITY

Congenital Dislocation of the Hip

Congenital dislocation of the hip joint is one of the commonest and most important of congenital deformities It is a partial or complete displacement of the head of the femur from the acetabulum probably as a result of some congenital malformation of the parts entering into the formation of the joint The number of cases in girls greatly exceeds those in boys It may be hereditary and accompanied by other anomalies of development.

Primarily there is no socket present on the wing of the ilium but the acetabulum is formed by condensation and growth of cartilage round the head of the femur In congenital dislocation the growth of this cartilage does not keep pace with the growth of the head. This retardation in the development of the postero-superior quadrant of the acetabular rim may be temporary provided that the area in question is carefully protected from any pressure such as would result if the head of the femur were dislocated from the acetabulum Congenital dislocation of the hip is therefore a symptom of hypoplasia of the acetabular rim the latter condition being the primary error

Pathology—**Changes in the Bones.**—The acetabulum is abnormally shallow owing to the failure of growth of the cartilaginous rim The cavity is converted from the normal circular contour into a triangular depression with its base in front and below and its apex above and behind The deficiency in depth is most apparent in its postero-superior quadrant On examining the pelvis from the front it will be seen that the outer surface of the ilium and the floor of the acetabulum lie practically in a straight line owing to the absence of the usual projecting rim at the upper part of the cavity Above the acetabulum on the dorsum ilii there is a depression lined with periosteum in which the head of the femur rests insecurely separated by a fold of capsule

The head of the femur is small atrophied and flattened on its medial and posterior aspects (Fig 603) In some cases it is absent

The neck of the femur is short depressed and sometimes anteverted so that the normal angle of 12 degrees is increased until in late cases it may be almost 90 degrees i e the neck appears to project straight forwards from the shaft As a result of this when the dislocation is reduced the limb is rotated medially and the patella looks directly inwards



Fig 603

Congenital dislocation of left hip. The head of the femur is displaced upwards and outwards and is less well developed than on the right side

In bilateral cases the pelvis is tilted forwards and the normal lumbosacral lordosis increased (Fig 604) The innominate bone is small and atrophied and lies more vertically than normally so that the iliac crests are approximated In unilateral cases the bone on the affected side is imperfectly developed while the whole pelvis has a lateral inclination and the shape of the inlet is obliquely ovoid

Changes in the Soft Parts.—The capsule is said to assume an hour-glass shape one cavity containing the head the other covering the acetabulum, the constriction between them being produced by the iliopsoas tendon which crosses the capsule at this level The capsule forms a suspensory ligament for the pelvis and indeed supports most of the weight of the body It accordingly becomes hypertrophied particularly at its anterior and inferior aspects



Fig. 604

Diagram illustrating the increased curve of the lumbar spine in congenital dislocation of the hip.

There is considerable alteration in the muscles Those running in the same axis as the femur are shortened and form a formidable obstacle to reduction The transverse muscles (the obturators quadratus femoris and psoas tendon) are stretched and elongated and become functionally incompetent The gluteal group show little organic change but since they are without their fulcrum their power is considerably diminished

The Dislocation.—Since the primary condition is a hypoplasia of the acetabular rim the dislocation is a secondary effect and in certain minor degrees of hypoplasia may not be present Nevertheless the mechanism for retention of the head within the acetabulum is insecure and dislocation may take place with the slightest trauma or even without it.

abduction internal rotation and hyperextension are greatly restricted. In very early cases it may be possible to elicit a soft, muffled crepitus

An X ray will show that the head of the femur lies in the acetabulum, but is rotated so that its lower and posterior borders are displaced downwards and outwards The head is slightly displaced in relation to the neck, its lower border projecting as a beak like process below the lower margin of the neck. The upper margin of the head is thinned out and separated by a short distance from the prominence made by the upper angle of the metaphysis

The *diagnosis* is suggested by the characteristic history the age of the patient and the adducted, externally rotated position of the limb In addition the radiographic appearance is so characteristic that in these days the condition should not be missed

Coxa vara is to be distinguished from (1) tuberculosis of the hip (2) Perthes disease and (3) congenital dislocation.

Treatment —In early cases when there is a minimal displacement, traction in a Thomas s splint is applied until the condition appears fixed Where much displacement has occurred the obvious treatment is to reduce the displaced epiphysis, and to maintain alignment until a new union takes place In very early cases it may be possible to reduce the displaced epiphysis by heavy traction with the leg adducted. If of recent origin manipulation may be attempted but it is unusual for it to be successful and most cases have either to be corrected by osteotomy or reduced by open operation This unfortunately often produces an avascular necrosis of the head

In dealing with an advanced case of some months standing but with an obvious line of demarcation still present between the head and the neck the hip should be exposed through a Smith Petersen incision, the head freed from the neck correct alignment secured and the reduction maintained by the insertion of a trifin nail.

In a healed case in a young adult an osteotomy of the femur just below the trochanter is the operation of choice

Coxa Valga

This in contrast to coxa vara signifies an abnormal elevation of the neck of the femur the angle which this forms with the shaft being greater than 140 degrees It is usually a congenital condition, and is not infrequently observed in limbs which have never supported weight.

The gait may be a little awkward the limb being rotated outwards and abducted The deformity is uncommon and of minor importance. In most cases function is very little altered

Where adduction is limited in some cases manipulative treatment is carried out to overcome this limitation An osteotomy has been described for the condition but is very rarely indicated

Snapping Hip

During certain movements of the hip joint an audible sound or click may be heard or felt In some cases the cause is intra-articular while in others it is due to factors outside the joint The former type is not

uncommon in children and results from slight voluntary displacement of the head of the femur over the upper border of the acetabulum

The more common extra-articular type is analogous with the dislocation of the peroneal tendon commonly seen at the ankle joint The snap is felt and heard when the knee is flexed and the hip rotated inwards A tight band is sometimes seen to slip backwards and forwards over the great trochanter

Where the condition is causing distress division of the offending band or tendon is usually sufficient to give a complete cure The operation should be carried out under local anaesthesia since it is essential to recognise which band is at fault To prevent post-operative recurrence the band may be sutured behind the trochanter After operation, early movement is essential

Genu Varum

Bow leg is an outward bowing through the upper and middle thirds of the shafts of the tibia and fibula Occasionally the femur is also involved Where the leg is curved in a forward direction the condition is termed anterior bow leg The existence of this deformity is presumptive evidence of some degree of rickets and is the result of the superincumbent body weight transmitted through soft bones There is usually an inward rotation of the lower end of the tibia on the long axis of the femur with the result that the toes are turned in, and, when the child stands with the feet together the knees are widely separated. On walking an obvious waddle is present

If the condition is observed while the process is still active correction is carried out by repeated manual manipulations Both extremities of the leg are grasped and bent outward for a few minutes three or four times daily care being taken that no strain is placed on the epiphysis while the manipulation is being carried out

If this is not successful a Knight's brace is used This consists of two steel uprights attached to the shoe with a soft leather pad fixed to the upper end of the medial upright to prevent undue pressure on the inner condyle of the femur The outer upright extends to the head of the fibula and the two are joined by a calf band. The bowed leg is drawn inwards towards the inner bar by a broad leather cuff laced about the leg inside the outer bar The inner bar may be gradually bent until over-correction is secured

Operative procedures are carried out only after the active process has subsided and consist in fracture without incision through the medium of an osteoclast or open osteotomy performed at the greatest prominence of the tibia

Genu Valgum

The deformity of knock knee develops as a rule in early childhood, and may be due to a temporary defect in the growth of the lower end of the femur or to rickets There is an inward projection of the knees and the leg deviates from the long axis of the femur at an abnormal outward angle In walking the feet usually turn in in a

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compensatory effort to clear the knees and the gait is unsightly as the knees rub together and the line of gravity is transposed to the outer side of the knee joint The gait is also lurching with an exaggerated side-sway of the body at each step to preserve balance The deformity disappears when the knee is flexed, because only the lower ends of the condyles are affected and not the posterior surfaces with which the tibia articulates in full flexion. Laxity of the medial collateral ligaments of the knee is often present and in the more severe degrees there is pes valgus

Treatment—The type called idiopathic—that is from defective growth of the femoral condyle—usually recovers spontaneously and the only useful measure is a wedge to the inner side of the heel and sole of the shoe

In the rickety type more active treatment is often required especially if the child is fat and the deformity shows a gap of 3 in between the malleoli A mermaid splint is used preferably and consists of two padded aluminium gutters joined together The legs are bandaged into the gutter with woven bandages so tending to straighten them

Operative measures used are of two kinds. McEwen's osteotomy carried out about 1½ in above the epiphyseal line on the outer side followed by correction and plaster is the usual one but Blount has suggested a method of temporarily stopping epiphyseal growth by the insertion of staples between the metaphysis and the epiphysis on the overgrown side The staples are removed when the deformity has been corrected.

Genu Recurvatum

This deformity develops frequently following paralysis of the quadriceps when the patient fearing that the knee will give way attempts to make the leg stable by locking the joint in hyperextension before bringing weight to bear on it The posterior part of the capsule is loose and the posterior muscles stretched.

The condition may also be congenital when it is caused by imperfect development of the quadriceps muscle and may be associated with rudimentary development or absence of the patella In congenital cases the legs bend forwards instead of backwards at the knee joint and there is often a forward displacement of the tibia on the femur In infants correction may be obtained by gradual flexion of the knee a *malleable posterior splint* being applied when the best possible position has been achieved At weekly intervals the knee is further flexed and the splint bent to conform to the new position. It must be retained until the right angle flexion has been maintained for at least a month

In older children, operative procedures are indicated to lengthen the contracted structures and are followed by prolonged immobilisation and support by braces Campbell has recently devised a bone-check operation in which the patella is secured to the anterior aspect of the upper end of the tibia. When satisfactory union has occurred between the patella and the tibia it will be found that the former forms a complete check to any hyperextension at the knee joint

Recurrent Dislocation of the Patella

The patella may subluxate as a result of trauma rickets or congenital anomaly The displacement is usually lateral The congenital type is often accompanied by other abnormalities In the traumatic type the internal part of the capsule is ruptured and the defect is filled in by scar tissue which stretches, allowing a gradual increase in laxity of the capsule on the inner side of the joint This obviously relaxes the inner ligaments to the patella and permits it to be displaced externally

Treatment—Reduction in most cases is easy With the knee fully extended the thigh is flexed to relax the quadriceps and the knee-cap manipulated into position by pushing it medially while at the same time correcting any rotation

Conservative measures are only of value before the displacement has become habitual and consist of the wearing of a knee-cage with an inner wedge on the heel of the shoe The operative measure which is most successful is the alteration of the insertion of the patellar ligament to a more medial position

Transplantation of the Tubercle of the Tibia.—This is the operation of choice An incision is made vertically downwards from the outer border of the patella to the outer side of the tubercle of the tibia from which point it deviates medially to end over the inner aspect of the tibia The ligamentum patellæ is defined and along with the small block of bone into which it is attached, is separated from the tibia A new bed is now made on the antero-medial aspect of the tibia its shape corresponding to that of the bony block at the end of the ligament This is inserted into its new bed and secured in position by a screw nail The operation may with advantage in certain cases be supplemented by a soft tissue operation consisting in division of all the shortened structures on the outer side of the patella

Albee believed that the condition is due to a failure of development of the external condyle of the femur and to correct this he raised the anterior part of the external condyle forwards and kept it forwards by inserting a bone graft under it

Congenital Talipes Equinovarus

Talipes is the term applied to a deformity of the foot and requires a qualifying adjective to denote the particular type Talipes equinovarus is a deformity in which there is a persistent plantar flexion and inversion of the foot with adduction of the forefoot and internal rotation of the tibia. It occurs usually in healthy boys and is more frequently bilateral than unilateral The condition is now believed to be a primary developmental anomaly associated with hypoplasia of all the bones and muscles of the foot Not infrequently there are abnormalities in the number or development of the bones Bohm believes that a primary endogenous disturbance of the embryo with arrest of its normal development accounts for the great majority of cases

In its early stages the condition is a persistence of the normal fœtal position of adduction inversion and plantar flexion The muscles are poorly developed and the tendons are delicate The plantar muscles especially on the inner side are tensely contracted while the anterior group of leg muscles is elongated

The ligaments on the medial and inferior surfaces of the joints between the os calcis astragalus and scaphoid are contracted as is also the internal lateral ligament of the ankle joint. Bone changes occur chiefly in the astragalus A large portion of its upper surface escapes from between the malleoli and becomes prominent on the dorsum of the foot This part freed from pressure becomes broadened and in severe cases is an obstacle to passive dorsiflexion of the foot The neck of the astragalus is longer than normal and is deflected downwards and inwards The os calcis is plantar flexed and tilted so that the medial process of the tuberosity approaches the medial malleolus The anterior extremity is deflected inwards, following the direction of the neck of the astragalus


Fig 611
Congenital talipes equinovarus

Clinical Features—The leg is smaller and less well developed than that on the healthy side The skin of the foot is usually stretched and thin on the dorsum and thrown into creases along the inner border and on the sole There are evidences of external pressure on the dorsum in the shape of callosities and scars The head of the astragalus is felt on the dorsum of the foot which faces downwards and forwards while the plantar surface is now rotated so that it looks upwards and backwards The outer border of the foot is convex and the inner concave The forefoot is plantar flexed upon the hind foot The heel is rotated inwards and drawn upwards throwing the whole foot into equinus (Fig 611) There is some internal rotation of the tibia on its long axis and, in many cases a well marked genu valgum The child walks with a markedly stumbling gait which lacks elasticity Bursæ and callosities develop over the weight bearing areas

With early and continued treatment all cases should be cured and a useful and properly shaped foot obtained. In older children the shape of the foot cannot be completely restored but the condition should be greatly improved

Treatment—Whatever type of treatment is advocated it is important to remember two cardinal rules —

1 The deformity must be over-corrected
2 This over-correction must be maintained until the patient's muscles are sufficiently strong to prevent relapse

The mode of treatment varies with the age and the extent of the deformity

1 **Treatment of an Early Case.**—The treatment of this type starts

on the first day of life and consists in manipulation This may be carried out by a capable nurse or masseuse who can quickly be trained in the proper method and in the amount of force to be used It is well to recall that there are three separate deformities which require correction (1) adduction and inversion (2) equinus and (3) internal rotation of the tibia They are attacked in this order and the maximum result of manipulation is maintained for a few seconds at each sitting The movements should be carried out as often as possible—at least three times a week They should be repeated until the deformity can be easily over corrected and until the foot muscles have developed the power of holding it in the corrected position They may then be gradually discontinued In all cases manipulation will have to be continued until the child begins to walk.

After the manipulation some form of retentive apparatus may be used. This may be simply adhesive plaster but as soon as possible the bilateral splint of Denis Browne is applied Both feet are incorporated in the apparatus and a good leverage for maintenance of correction is got from the other foot

At a later stage if the equinus deformity has not been completely overcome it may be necessary to divide the tendo achillis This is done by subcutaneous tenotomy While the child is under an anaesthetic the opportunity should be taken to manipulate the foot freely and to over-correct any remaining deformity The foot is thereafter put up in plaster of Paris in the over-corrected position The plaster is applied with the knee bent is carried up to the middle of the thigh and is retained for three or four weeks.

Supervision should be continued until the child has begun to walk The deformity may be considered as cured when there is no adduction or inversion deformity when there is a hollow on the dorsum of the foot in the position previously occupied by the head of the talus and when the child is able to evert the foot and dorsiflex it to about a right angle

2 Treatment of Older Patients, Previously Untreated.—At this stage manipulation requires to be carried out under a general anaesthetic The foot is manipulated with a Thomas's wrench or by the Denis Browne method, using a wooden vice Once the deformity is corrected physiotherapeutic measures are used to mobilise the joints and to develop the muscles In the intervals the foot is kept in the corrected position by means of a Browne's club-foot splint of light aluminium When the child is allowed to walk the outer side of the sole of the shoe is raised to maintain the foot in good position The use of the splint should be continued during the night for many months

3 Treatment of Old and Relapsed Cases.—In many cases manipulative treatment is not sufficient because of rigidity or a constant tendency to relapse In this type of case an operation is necessary

Brockman's operation is one on the soft tissues of the inner side of the foot All the structures including the tendon of the tibialis posticus

are erased from the inner and plantar aspects of the subtaloid and midtarsal regions. When correction is obtained by manipulation it is maintained by a plaster case Later the tendo achillis may be lengthened subcutaneously

4 **Treatment in an Adult.**—In the adult an operation on bone is necessary in most cases to obtain any satisfactory degree of correction The best operation is a triple arthrodesis of the subtaloid and midtarsal joints after the manner of Naughton Dunn Removal of suitable wedges of bone and division of the astragalo-scaphoid capsule and the internal lateral ligament makes it possible to manipulate the foot into the correct position without undue force The foot is encased in a plaster reaching to the knee for six weeks.

Pes Planus

Flat foot is a condition in which there is a persistence of the passive or resting attitude of pronation during periods of active movement. There is a consequent loss of the longitudinal arch of the foot The attitude of passive pronation becomes more persistent and movements restricted until eventually there is a fixed deformity The foot is not flat because its key-stone has sunk, but because its arch is lowered as a consequence of lateral displacement or so-called abduction. Every grade of severity in the disability and deformity is found.



Fig. 61

The abduction of the foot in pes planus showing how the os calcis deviates outwards.

Flat foot may be hereditary but it may supervene on any condition associated with weakened muscles. The predisposing causes are ill fitting shoes, bad methods of walking or loose methods of standing while among the intrinsic causes are congenital and acquired abnormalities as in rickets in early childhood and muscular weakness in quickly growing adolescent girls A common cause is strain of the foot from prolonged standing or walking as is so frequently seen in nurses Over weight may be caused in two ways either by obesity the common way or by the carrying of excessive weights as is seen sometimes in the brewer's drayman

If a straight line is prolonged downwards from the centre of the leg most of the astragalus and os calcis will be lateral to it hence the body weight pressing on the medial side of the foot tends to flatten the arch and cause outward rotation—tendencies which are antagonised by the flexors of the toes and by the tibialis posticus muscle The os calcis is pronated and pushed laterally The astragalus moves over the os calcis and the ligaments are stretched (Fig 612)

Symptoms —In the lesser degrees of the deformity it will be noticed that the feet are hot and uncomfortable and that they perspire freely after use Stiffness and lameness follow After a heavy day's exercise patients are particularly unhappy while they are comfortable after a day of rest The method of walking becomes inelastic and clumsy Patients walk with their feet everted and are unable to rise on the toes

Pain is severe when standing and may be experienced in sever places—under the tubercle of the scaphoid from stretching of th inferior calcaneo-navicular ligament below the internal malleolu along the astragalo-calcanean joint and down the inner surface the os calcis In some cases the tip of the external malleolus and th outer surface of the os calcis may be painful as well as the dorsum the foot Pain is due to stretching of ligaments and compression of the tissues below the external malleolus Synovitis is not uncommonly present in the tendon sheath of the tibialis posticus or of the peroneus longus Localised swelling of the foot is common and in some cases œdema occurs



Fig. 613
Pes planus showing t outward rotation of t leg—the position used walking

The gait is clumsy since the patient commonly avoids raising the heel so preventing the thrust on the tarsal and metatarsal ligaments Outward rotation of the feet and legs is a favourite method of preventing strain on the plantar ligaments (Fig. 613) He shuffles forwards and the foot is turned over its inner border instead of over the balls of the toes thus further flattening the arch

Muscle spasm is common especially in the peroneal muscles which may be tightly contracted and can be seen standing out under the skin Attempted correcti induces pain along the course of these muscles Painful corns m form in the distal weight bearing areas i e under the heads of th metatarsals

Types of Flat foot —Flat foot may be divided into four stage although these merge into one anoth without any sharp line of demarcati (*Fig 614*)



Fig. 614
Imprints of various degrees of pes planus.

1 **Voluntary Flat-foot.**—In this type th deformity is corrected when the foot is rais from the ground

2 **Resistant Flat foot.**—*In this type th* deformity may be corrected by manipulatio

3 **Rigid Flat-foot.**—In this type an anæsthetic and possibly even a Thomas wrench, is required before the deformity can be corrected

4 **Permanent Flat foot.**—In this type no amount of manipulatio even under an anæsthetic will restore the arch If correction essential it *has to be obtained by an operation* usually implying t removal of bone

Treatment—1 **Paralytic Flat-foot.**—*In this* type treatment shou be directed towards the strengthening of the weakened muscles b means of exercise electricity and massage To maintain a corre position suitable braces are applied. In some *cases of* paralyt *flat* foot it may be advisable to ankylose the ankle *joint by operatio* Such a bone operation however is not indicated before the twelf year It may be possible *to* transplant some actively functioni tendon to help restore the balance of the foot

2 **Static Flat-foot.**—The object of treatment in this case is to correct the abnormal centre of gravity and to remove the pressure symptoms the indications being pain and impaired function.

Methods of Treatment—1 **The footwear** of the patient should be carefully examined and, where necessary corrected The shoe should have a slightly concave inner border an accurately moulded waist and in most cases the body weight should be transferred to the outer border of the foot by means of an inner wedge of leather Care should be taken in the case of growing children that they do not outgrow rather than outwear their shoes

2 **Physiotherapeutic Treatment.**—Exercises both in the sitting and weight-bearing positions form an important part of treatment. They are performed twice daily and in children may be modified and carried out to music so that they are less tedious than they would otherwise be The exercises are directed towards the stretching of shortened structures and to the strengthening of weakened muscles In some cases faradic stimulation of the small muscles of the foot is most effective in increasing their tone Contrast foot baths of cold and hot water are useful and stimulating



FIG 615
Whitman valgus spring.

3 **Supports for the Arch.**—Sponge rubber pads afford a resilient support and increase the spring of the gait They are easily cleaned retain their resiliency for a long time and are comfortable to wear

In some of the minor degrees adhesive plaster strapping is a desirable means of support It should be changed every week until the symptoms disappear The adhesive strapping is carried from the outer side of the foot under the central part of the longitudinal arch and fixed to the antero-internal surface of the leg in such a way that its anterior edge can be made smoothly adherent to the dorsal surface of the instep

One of the most efficient appliances is the Whitman valgus brace (Fig 615) which since it clasps and holds together the weak part of the foot serves effectively to restrain deformity and to ensure such an attitude that the patient cannot avoid using the muscles which adduct and invert the foot The brace is made for each individual from a cast of the foot and consists of duralumin or aluminium

4 **Instruction in Walking** The patient should be taught to walk with the feet parallel as the muscles supporting the arch are then more active and produce adduction and inversion of the foot The heel-and toe walk also brings strong muscles into play and should be cultivated

5 **Manipulation.**—Many cases of spastic or rigid flat foot must be manipulated to produce mobility before other treatment is instituted In some cases the manipulation has to be carried out forcibly with a Thomas s wrench but in other cases the operator s hand is sufficient. The foot is forced downward then inwards then upwards into extreme varus and an attempt is made to get the outer border of the inverted foot up to a right angle with the leg The arch is completely

restored and a plaster of Paris case applied from the toes to the tibial tubercle with the foot in a position of talipes equinovarus Walking in the plaster case is allowed as soon as the patient wishes

6 **Operative Treatment.**—Spastic flat foot is improved by tenotomy of the peroneal muscles followed by manipulation and a plaster-of Paris case In the very extreme degrees an astragalo-scaphoid arthrodesis may be carried out and a wedge removed from the prominent navicular and inserted into the region of the calcaneo-cuboid joint so shortening the inner side of the foot and lengthening the outer (Fig 616)

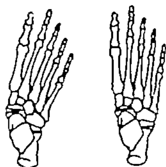


Fig. 616
The corrective operation for pes planus as explained in the text

Treatment of the Various Types—1 The **Voluntary Type.**—Any cause that may be operating in the production of the deformity is removed *e.g* obesity strain faulty attitudes If there is extreme tenderness and œdema the patient should be put to bed for two or three weeks Thereafter the footwear may be inspected and properly fitting shoes prescribed He should be taught to walk properly Physiotherapeutic exercises are ordered and the feet supported for a few weeks by adhesive strapping after which a sponge-rubber arch support may be worn

2. **The Resistant Type**—The treatment of this is similar to the last but instead of the sponge rubber a Whitman valgus brace may be recommended

3 **The Rigid Type.**—The foot is manipulated under anæsthesia until it is flaccid and mobile It is then put up in plaster in a position of talipes equinovarus for five weeks and thereafter treated as the second type

4 **The Permanent Type**—This requires operative interference usually a bone operation to correct the deformity The treatment thereafter is on the usual lines

Claw Foot

The term claw foot or **pes cavus**, is applied to a deformity in which there is clawing of the toes combined with a raising of the longitudinal arch of the foot and shortening of the tendo achillis It may be either congenital or acquired but even in the former it is not usually apparent until the child is 6 or 7 years old It may be associated with spina bifida occulta



Fig 617
Pes cavus.

Claw foot frequently follows an attack of poliomyelitis or progressive lesions of the central nervous system but most commonly no cause for it can be assigned and in these cases it is called idiopathic claw foot (Fig 617)

In the early stages the principal sign is a relative weakness of the dorsiflexors but as the condition advances the plantar fascia appears to become too short for the bony structure of the foot so that the arch gradually rises The plantar fascia is felt to be tense and contracted

until the metatarso phalangeal joint has become greatly enlarged and a bunion has formed There is then a partial subluxation of the joint. A bursa develops over the prominent head of the metatarsal while a corn or callosity forms in the covering skin The projecting bone the bursa and the thickened tissues are collectively known as a *bunion*.

The other toes are usually displaced outwards the forefoot is broadened and the metatarsal arch depressed The deformity may be combined with a weak foot although in many instances the longitudinal arch is of a normal height

The chief sign is the outward displacement of the great toe with resulting prominence of the head of the first metatarsal. The deformity is aggravated by the pull of the tendon of the extensor longus hallucis which is displaced outwards and lies stretched along the lateral border of the great toe like a bowstring The symptoms are pain swelling and redness The pain may be due to bursitis to arthritis or to a digital neuritis

The condition is often bilateral, although the pain and discomfort are frequently more marked on one side

Treatment—In mild cases relief is obtained by the provision of properly fitting shoes which relieve pressure on the tender joint None of the devices for holding the toe in an improved position have any curative value nor do they usually relieve the symptoms. If these are at all severe operation should be advised

Where the joint is moderately healthy and in the absence of arthritis removal of the exostosis and bursa is sufficient to give at least temporary relief but where there is any degree of arthritis an arthroplasty of the joint should be carried out A resection of the base of the proximal phalanx is done thus preserving the weight-bearing part of the tripod of the foot The extensor longus hallucis tendon may require to be lengthened A flap of deep fascia containing the bursa is then turned into the space between the metatarsal and the phalanx and fixed there with catgut Pulp traction is applied to the toe for about three weeks Passive movements are begun after the removal of the plaster and the patient is allowed to walk at the end of the fourth week

Hallux Rigidus

This is a painful affection of the first metatarso-phalangeal joint characterised by limitation of dorsiflexion When a flexion contracture of the joint is present the name *hallux flexus* is applied The joint is usually swollen from periarthritis and attempts at passive movement produce pain Pain is also experienced when standing and more particularly on walking There is often a history of injury such as stubbing the toe or kicking a hard object

In the acute case relief is obtained by resting the foot in plaster and putting traction on the toe by means of pulp traction

In minor degrees of the affection great relief is obtained by restricting the movement of the joint by the insertion of a narrow strip of tempered steel between the two layers of the sole

Where the condition is associated with a weak foot this deformity may first be corrected under anaesthesia and the foot retained in a corrected position by a plaster bandage When arthritis is present however an operation on the lines of that used for hallux valgus is necessary where the base of the phalanx is excised and an arthroplasty carried out by turning in a flap of soft tissues between the bone-ends Traction is applied to the toe for two to three weeks

Hammer toe

The deformity of hammer toe consists in dorsiflexion of the proximal phalanx plantar flexion of the second and flexion or extension of the distal The second toe is usually affected the head of the first phalanx being subjected to pressure by the toe-cap of the shoe as a result of which it frequently shows a painful corn Underneath this there is often an inflamed or even suppurating bursa. The condition is in many cases bilateral and may be associated with hallux valgus or pes cavus

In young children the distortion may be overcome by repeated manipulation the corrected position being maintained by strips of adhesive plaster passing over and under the affected toe and its neighbours The use of digitated stockings and of wide boots is also beneficial.

In adults operation is indicated in order that recovery may be certain and quick. Amputation is never performed, but an excision of the head and neck of the proximal phalanx allows the toe to be straightened The operation is carried out through an elliptical incision which excises the corn and underlying bursa. It is often necessary to tenotomise the extensor tendon and the dorsal capsule of the metatarso-phalangeal joint to obtain correction

Anterior Metatarsalgia

This is caused by faulty weight bearing on the fore foot If from a short first metatarsal or from a convexity of the metatarsal head in a downward direction an undue amount of weight is taken on the metatarso-phalangeal joints these being ill protected are injured A badly fitting shoe especially of the woman s type with high heels and narrow toes is the main offender in producing this condition though intrinsic muscle weakness and trauma are often also to blame



Fig 619

Metatarsalgia On the left is section of normal foot, on the right section showing how the heads of the 2nd, 3rd and 4th metatarsals sink with the dropping of the transverse arch

Pain is usually felt over the affected joints at first but may radiate over the foot It varies in degree but tends to get worse and may even prevent walking The pain is situated over one of the metatarsal heads and is increased by dorsiflexion of the toe Occasionally superficial oedema is seen Callosities occur at a late stage under the metatarsal heads

2 **Treatment during the Acute Stage**—Intravenous injections of hypertonic salt solution cause a reduction in volume of the brain and cord and are useful in the acute stage for lessening pressure on important nerve centres. Ten cubic centimetres of a saturated solution of magnesium sulphate may also be used with the same effect. Lumbar puncture is frequently employed to relieve pressure

Complete rest is enforced during the early part of the paralytic period Any movements or manipulations prejudice the chances of recovery The patient lies recumbent and it may be advisable to apply a plaster shell to his body Pain and tenderness may be relieved by local hot baths Every effort should be made throughout this stage to prevent deformity and every affected joint or limb is placed in a position of optimum functional utility and splinted to maintain this position, though during the painful phase this may well be left for a few days Hot fomentations are helpful but massage is harmful

3 **The Convalescent Stage**—When the acute symptoms have subsided an attempt is made to restore the greatest amount of efficiency to the atrophied muscles Where there is any paralysis of the trunk it is wiser to keep the child lying on his back, but where the paralysis is limited to one or even two limbs, the circulation may be favoured by allowing him to get up To avoid deformity however some form of apparatus must be used. It not only prevents deformity but may correct it. It certainly prevents the stretching of paralysed muscles and in many cases permits of or improves walking An abduction splint may be used for the shoulder a cock up for the wrist a walking caliper for hip and knee cases and other splints of similar function for other parts of the body

The active therapeutic measures which are employed are massage heat electrical stimulation of muscles and muscle training These should be carried out under a trained masseuse who realises that the main essentials of treatment are the avoidance of stretching and fatigue of muscles and the prevention of deformity Unfortunately the surgeon is often not called in until deformity is present.

Some of the various types of established deformity must now be considered.

Hip-flexion Contracture.—This disabling contracture is a result of contraction of the tensor fasciæ femoris iliopsoas sartorius and rectus femoris It is usually associated with some adduction of the hip a flexion deformity of the knee and often a shortening of the tendo achillis In the early stages it may be cured by putting the patient in the prone position for some hours daily but usually an open operation has to be carried out The operation of choice is that described by Souttar whereby the flexors of the hip are stripped subperiosteally from their original position and allowed to slip down the side of the pelvis The thigh can then be extended and the deformity completely corrected It may in addition be necessary to divide the iliopsoas muscle Where the anterior spine projects through the wound after the muscle slide has taken place it should be cut off flush with the surface and the wound closed The patient is afterwards placed in a plaster spica with the hip hyperextended for two or three

weeks until the wound has healed and the muscles have become united to their new attachment

Flexion Contracture of the Knee—This occurs commonly in association with flexion contracture of the hip and is often present in paresis of the anterior thigh muscles and overaction of the posterior group The deformity can be prevented by a Thomas's knee splint but when it has become established it is often possible to reduce it by means of a wedge plaster (Fig 621) A circular plaster is applied to the leg from the toes to the groin in the position of the deformity and allowed to harden Thereafter a transverse section of the plaster is made through the posterior three-quarters at the level of the knee joint A spreader is then inserted into the slit to force it open the leverage being so favourable that the knee can be gradually straightened out When completely straight a few turns of plaster are applied to maintain the corrected position for some weeks

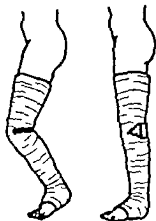


FIG. 621

Flexion deformity of the knee treated by a wedge plaster

Deformities of the Ankle Region.—Drop foot is the commonest deformity and develops in cases of paralysis of the extensors of the ankle It has to be remembered however that a slight contracture of the tendo achillis is an advantage in some cases of infantile paralysis where secondary shortening of the leg has taken place as it compensates to some extent for this (Fig 622) It is also useful in cases of quadriceps insufficiency When weight is borne on such a limb the strain on the gastrocnemius muscle locks the knee joint and increases the stability The tendo achillis therefore should not be divided without careful consideration lest the stability of the leg be imperilled The operation of lengthening is carried out through a vertical incision about 6 to 8 in long on the medial aspect of the tendon The tendon is exposed and divided into anterior and posterior halves by a long lateral, vertical splitting incision The anterior half is detached from its insertion into the os calcis while a transverse incision is made through the posterior half of the tendon at the upper end. In this way two broad flaps are secured The foot is then brought into a right angled position and the two flaps of the tendon stitched together with chromic catgut The sheath is stitched over the tendon and the skin incision closed Immobilisation should be maintained in a plaster-of Paris case for about six weeks by which time the tendon should be united Thereafter support may be obtained from the use of a strong boot



FIG. 622

Types of deformity in infantile paralysis.

A, left talipes calcaneo-varus; B, right talipes equino-varus.

4 **Treatment in the Chronic Stage of Infantile Paralysis.**—The object of treatment in this stage is to improve the function of the limb and the operations used are grouped into two main types—those which improve muscle balance and those which secure stability These operations are not carried out until two years have elapsed from the onset of the disease as there is always a chance of some recovery of muscle power until that date Muscle balance is improved by tendon transplantation—a normally functioning muscle taking the place of one which has become paralysed. In this way muscle balance is restored deformity may be corrected or prevented and stability improved. An instance of such transplantation is in the case of quadriceps paralysis, when one of the flexor group is carried forward to take the place of the paralysed extensors

In addition to using tendon transplantations great improvement may be gained by bone operations—or stabilisation operations as they are called—whereby a flail joint is arthrodesed. In this way the shoulder elbow wrist, hip and knee may all be stabilised. There are many stabilising operations in use on the foot which from lack of muscle power has become flail partially or completely Often these operations are supplemented by tendon transplantation

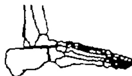


FIG. 623
Naughton Dunn's reconstruction of the foot.

The Naughton Dunn Operation.—This is carried out through a straight oblique lateral incision and consists of an arthrodesis of the subastragaloid and midtarsal joints A portion of bone with the articular surfaces is removed from between the os calcis and the cuboid. The head of the talus the whole of the scaphoid and the proximal cartilaginous surfaces of the cuneiform bones are then removed (Fig 623). In this way there is a reconstruction of the fore foot in the nature of a shortening The foot is displaced backwards at the subastragaloid joint The foot is put up in plaster for three months. In cases where there is a loss of power in the calf muscles an arthrodesis of the ankle joint may also be done

SPASTIC PARALYSIS

Spastic paralysis of infancy and childhood is due to disease of or injury to the cerebral motor centres affecting the upper motor neurones which control the muscles of the extremities It is also known as Little's disease or infantile cerebral spastic paralysis If one extremity is involved, the term monoplegia is used when half the body is involved, hemiplegia both legs paraplegia both arms and legs diplegia or quadriplegia The two latter types are usually congenital. The hemiplegic type often occurs during the first few years of life and usually follows disease This may be antenatal in origin but more often dates from the time of birth which has usually been difficult and often carried out with the aid of forceps

Frequently the first sign of any serious disturbance following a difficult birth may be a convulsion indicating the cerebral origin of

the disease The mother may notice the child's difficulty in controlling movements of the extremities

The Paralysis is of the upper neurone or spastic type and is characterised by the hypertonic condition of the affected muscles and the exaggerated reflexes There is no wasting or reaction of degeneration. Muscular rigidity is marked and leads to spasm particularly of the adductors of the lower limbs when the child begins to walk. Any attempt to straighten the limbs is resisted but they can be gradually stretched if pressure is maintained Whenever the pressure is released the spasm returns

The deformities which result depend upon overaction of the stronger groups of muscles In the lower limbs the hips are flexed adducted and rotated inwards the knees are flexed and the feet are usually in a position of equino-varus. In the upper limb there is flexion of the elbow the forearm is pronated the wrist flexed and the thumb adducted and pressed into the palm by the flexed fingers

Certain curious involuntary movements often develop and interfere greatly with the function of the limb These are often in the form of rhythmical athetoid movements or may belong to the perverse movement" group They are limited to the affected limb and are usually more troublesome in the arms than in the legs

Mental deficiency varies with the severity of the limb affections but is present in all degrees Epileptic seizures are commonly associated with hemiplegia

There may be some impairment of growth in the limb

A diagnosis has to be made between poliomyelitis idiocy cerebral tumour and hydrocephalus

Without treatment the prognosis is poor but mild cases improve considerably with treatment and even in severe degrees some amelioration may be expected.

Treatment —Massage is worse than useless as it increases the tone of the already hypertonic muscles Muscle re-education is the most important part of the non-operative treatment The patient is taught to use the weaker muscles The hand is assisted by passive movements until the maximum of normal voluntary movement is reached and then gently stretched before the limb is passively replaced in the flexed position. This cycle is repeated frequently The patient is taught to carry out coarse movements of the limb before attempting the finer movements of the fingers Movements may be performed to the accompaniment of a metronome or music

Operative Treatment.—One does not usually operate until the age of 5 or 6 years as children are unable to co-operate before that time Mental enfeeblement athetoid movements and epileptic seizures to some extent contraindicate operation

The operations are divided into those on the nervous system and those on muscles and tendons

The only operation of real value on the nervous system is that of Stoffel. This relaxes the spasm in a certain number of muscle fibres in each muscle by cutting out part of its nerve supply Stoffel demonstrated that the various tracts run independently in a large

nerve and that the position of any bundle is remarkably constant Surgeons however do not now operate after this method but prefer to follow the nerve down till its individual branches can be traced It is then easy to resect a number of the fibres going to any particular muscle

The operations on muscles and tendons include tenotomy and myotomy tendon lengthening excision of portions of tendons and muscles and transplantations

Adduction Deformity of the Hip.—Although improvement may be secured by tenotomy of the adductor muscles better results are obtained by division of the nerves after the method of Stöffel The obturator nerve is approached through an abdominal incision The nerves on both sides may be operated on at one time The type of operation depends upon the extent of the spasticity After the operation the legs are manipulated into an abducted position and fixed in this position in a plaster-of Paris case for some weeks (Fig 624)

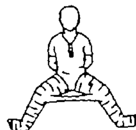


FIG. 624

Type of plaster applied after the operative treatment of adduction deformity of the legs.

Flexion of the Knee may be treated by lengthening of the hamstring tendons when there is a permanent contracture of these muscles but when this is due to spasm alone and can be corrected by pressure a modified Stöffel operation may be carried out on the sciatic nerve

Pes Equinus.—Here one must know the type of muscular shortening whether it can be overcome by pressure or whether actual adaptive shortening of the tendons has supervened. In cases of organic contracture the tendo achillis must be lengthened, but if the deformity is due to spasm alone a Stöffel operation may be carried out on the tibial nerve to paralyse to some extent the gastrocnemius and soleus

A vertical incision is made down the centre of the popliteal space and the nerve isolated and traced down to the calf Two branches leave the main trunk to supply the outer and inner heads of the gastrocnemius There are also the branches to the dorsal portion of the soleus and the plantaris The ventral portion of the soleus is supplied by a branch coming from the anterolateral aspect of the main nerve while the nerve to the tibialis posticus is found on the posterolateral aspect.

In moderate cases of pes equinus the nerves to the heads of the gastrocnemius should be resected and in more severe cases one half of the nerve to the dorsal portion of the soleus should also be excised In severe cases the entire tract may be removed. The knee should be kept extended on a splint with the foot at a right angle for three weeks to allow complete healing of the wound

CHRONIC LOW BACK PAIN

Pain in the lower part of the back is so variable in its causes its character and its treatment that it forms quite a problem to the examining surgeon to elucidate which a very comprehensive method of investigation has to be undertaken

This investigation will start with a careful description of the history of the complaint particulars being recorded of the method of onset the origin of the pain its situation radiation and duration Accompanying complaints in other parts of the body are noted—such as in the feet other joints or the genito urinary system Thereafter the patient is stripped and examined in both the erect and recumbent positions Any abnormalities of posture curves or movement are readily seen Points of tenderness in the lower part of the back are very helpful in localising the anatomical position of the probable site of the pain Finally an X ray examination is made of the suspected site and its neighbourhood both an anteroposterior and a lateral view being necessary In addition in many cases an examination of the urine blood and the cerebrospinal fluid may disclose significant features

LOW BACK PAIN ASSOCIATED WITH CONGENITAL ERRORS

A vertebral body is occasionally the site of some congenital *error* but it is unusual for this to be associated with low back pain This error usually results from some deviation from the normal in *ossification* The body may develop in two halves as there are two *centres of ossification* and in some cases one half may entirely fail to grow with the production of a hemivertebra but this is much more common in the upper part of the spine *Sometimes two vertebral* bodies fuse together This condition is usually symptomless

The articular facets of the lumbosacral joints vary in shape and in the plane of *their surfaces* and when one *lateral* facet is directed backwards and the other medially it is *thought by some* that this may be a cause of low back pain

The Neural Arch.—The principal anomaly occurring in *this part* is a lack *of fusion* between the two halves of the arch this occurs commonly in the fifth lumbar or the first sacral vertebra constituting the error of spina bifida *occulta* *This is* sometimes made clinically evident by the presence of a small tuft of *hair or a dimple in* the skin at the region Such a defect may produce instability in the lumbosacral region and low back pain.

Spondylolisthesis *is* the name given to the condition where one body—usually the fifth occasionally the fourth or even the third lumbar —slips forward on the lower body carrying with it the superincumbent lumbar spine *This is* thought to be due primarily to a variation in the ossification of the affected vertebra where instead of one primary centre for each half of *the arch, there* are two centres in each the two parts being united by a *plate of cartilage* set obliquely between the superior and inferior articular processes. The apposition of the inferior articular process *of the* upper vertebra with the articular process of the lower *one checks* any forward displacement of the vertebra and if there is any solution of continuity between the two articular processes displacement easily occurs It is quite likely that the slip is initiated by trauma either single or repeated

The patient complains of backache and pain occasionally in the lower extremities but in a great number of *cases no* such symptoms

nerve and that the position of any bundle is remarkably constant Surgeons however do not now operate after this method but prefer to follow the nerve down till its individual branches can be traced It is then easy to resect a number of the fibres going to any particular muscle

The operations on muscles and tendons include tenotomy and myotomy tendon lengthening excision of portions of tendons and muscles and transplantations

Adduction Deformity of the Hip—Although improvement may be secured by tenotomy of the adductor muscles better results are obtained by division of the nerves after the method of Stöffel The obturator nerve is approached through an abdominal incision. The nerves on both sides may be operated on at one time The type of operation depends upon the extent of the spasticity After the operation the legs are manipulated into an abducted position and fixed in this position in a plaster-of Paris case for some weeks (Fig 624)

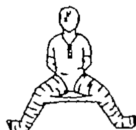


FIG. 624

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are present and indeed the condition is usually symptomless and therefore often discovered by accident. The pain when present is relieved by rest and aggravated by hard work It is of a dull aching character and the back feels weak and stiff but only a few of the patients are aware of any deformity

In the fully developed case the trunk is shortened, and transverse skin creases are seen encircling the body between the ribs and the iliac crest The lumbar curve is increased and the sacrum is prominent while there is a still greater prominence of the fifth lumbar spinous process with a depression above it Occasionally a slight degree of scoliosis is present owing to the unequal slipping forward of the vertebra and the consequent rotation Flexion of the spine is restricted in the immediate area but it is a notable feature that such patients are usually able to touch their toes with their hands in the straight leg bending exercise

The diagnosis is confirmed by radiographic demonstration of the displacement This can be seen even in the anteroposterior picture which shows a characteristic arc or bow of the anterior border of the slipping body while in the lateral view the vertebra is seen displaced forward on the sacrum or lower vertebra A further characteristic feature is a break in the lamina which appears as a gap continuing the clear space of the lumbosacral joint backwards above the spinous process of the fifth lumbar Often there is some bony buttress formation attached to the anterior surface of the sacrum under the projecting portion of the slipping vertebra

Many cases have few symptoms and accordingly no treatment is indicated In slight cases a conservative method of treatment is adopted by fitting the patient with a strong lumbosacral corset. Where the symptoms are extreme operation is suggested—either a posterior arthrodesis after the manner of Albee or Hibbs or in some cases where the pain is due to nerve pressure from an extruded disc the latter is removed entirely and the space filled with bone chips so ensuring an ankylosis

Sacralisation of the Transverse Process of the Fifth Lumbar Vertebra.—This is a developmental anomaly where one or both transverse processes are abnormally large and strong Occasionally they are so large that they form an intimate connection with either the upper part of the sacrum or even with the iliac crest The condition is due to an overgrowth of the costal element a centre of ossification additional to the normal one for each lateral process.

Symptoms usually start about the age of 18 to 20 when pain is complained of on the affected side low down in the back Occasionally there is a history of trauma after which the pain becomes almost continuous and is accompanied by a feeling of tiredness Acute exacerbations occur The patient is unable to sit comfortably on the buttock of the affected side and as is usual with such pain it is worse after exercise or when tired but is improved by lying in bed or by the wearing of tight corsets

Usually a certain amount of flattening of the lumbar curve is seen and occasionally there is a lumbar scoliosis with the convexity to the

affected side in unilateral cases This remains even in the sitting posture The sacrospinalis is tense There is tenderness over the sacro-iliac joint on the affected side and occasionally down the sciatic nerve

An X ray will confirm the enlargement of the transverse process and a stereoscopic examination will show whether this abnormal process is articulating with the first sacral segment or with the ilium The probable cause of the pain is a distraction of the sacro-iliac joint produced by the leverage of the abnormal process in lateral movement of the spine

Many cases are helped by the fitting of a tight sacro-iliac corset but in some cases it is necessary to operate and remove the affected process or at any rate the terminal part of it which is forming the abnormal articulation

LOW BACK PAIN ASSOCIATED WITH TRAUMA

Sacro iliac Strain

The condition to which the term *sacro-iliac strain* is applied occurs when a mechanical force or injury forces the joint to one or other of the extremes of range of movement and the joint then becomes locked The symptoms vary considerably but pain is usually experienced over the posterior aspect of the joint and may be elicited by digital pressure in that area It is increased by movements which put added strain on the joint and is more severe at night because the normal lumbar lordosis is obliterated and more strain is then thrown on the joint The pain is increased by the menstrual periods and by standing for long periods Usually the body is inclined away from the affected joint In stooping flexion of the trunk is avoided and in walking short steps are taken Movements of the body on the thighs or of the thighs on the body are limited while straight leg bending is much restricted

Among the symptoms stated by Albee to be pathognomonic of sacro-iliac disturbance are pain in the joint on turning over from the recumbent position pain while sitting on a hard chair relieved by sitting on the opposite buttock pain in the affected joint on forward bending tenderness on deep pressure over the joint and listing of the whole spine to the opposite side

There are no characteristic X ray changes in sacro-iliac strain until the condition has become so chronic that arthritis has set in when the usual signs of an osteo-arthritis may be seen

The usual treatment for such a condition is manipulation but care should be taken to exclude the possibility of tuberculosis or other abnormality before this is undertaken Usually a single manipulation produces a dramatic result in the acute case but in chronic lesions other etiological factors, such as postural defects gross overweight and so forth have also to be considered In cases where manipulation fails to improve the condition it may be necessary to arthrodese the joint after the manner of Smith Petersen

Lumbosacral Strain

Lumbosacral strain occurs in both acute and chronic forms The acute form may be caused by a sudden blow forcing the joint into positions beyond the normal range of movement or by any sudden movement whereby the erector spinæ muscles are caught off their guard and the ligaments thus sustain the full force of the injury

The chronic form is usually slow in onset but may follow an acute strain which has been unrecognised and untreated.

In acute cases with a history of recent trauma the pain and tenderness are situated at the lumbosacral junction and the movements of the spine are restricted in all directions A lumbosacral case will bend forward freely whether sitting or standing because he holds the lumbosacral region rigid and flexes chiefly at the hip joints.

In the chronic case the symptoms vary often the patient complaining only of a weak back Frequently there is a history of intervening periods of comfort lasting several years between attacks of pain but gradually the attacks become more and more frequent and constant as age advances

In the acute stage rest in bed for a few weeks is essential The patient lies in a bed fitted with fracture boards with pillows placed beneath the knees and lumbar spine When the acute symptoms have subsided massage radiant heat and diathermy are of assistance The chronic cases are more difficult to treat, and in them it is necessary to seek the underlying cause such as a postural defect increase of weight or active toxic foci Thereafter exercises to increase muscle tone and improve the posture form the essential local treatment Where the abdomen is pendulous it is helpful to fit a support of the lumbosacral belt or strong corset type

In severe cases of long-standing which may have failed to react to conservative treatment the joint may be arthrodesed in a manner similar to that described for tuberculous disease of the spine (p 1145).

LOW BACK PAIN ASSOCIATED WITH PATHOLOGICAL CHANGES

Spondylosis Deformans

In such cases the spine as a whole undergoes progressive deformation and widespread osteophytic formation occurs There is considerable interference with the mobility of the spinal column and pressure is likely to be enforced on the nerves in relation to it It occurs principally in men and especially those who have had a strenuous occupation such as outdoor labourers miners etc In the early stages the back is uncomfortable and the patient has difficulty in carrying out certain movements There is a history of frequent attacks of lumbago the pain never completely disappearing and one attack merging into the next With each successive attack the spinal symptoms become more marked and the movements more limited Pain is worse in the morning when the patient gets out of bed

If the patient is seen for the first time only after deformity has developed attempts should be made to correct this gradually by rest in bed on appropriate pillows Frequently manipulation of the spine is helpful in the early stages when there are more adhesions than osteophytes This is followed by hot baking either by fomentations or radiant heat and exercises The more the patient exercises the more likely is he to retain movement in the spine

Spondylitis Ankylopoietica

This is probably primarily an infective condition of the small spinal joints which is later characterised by deposition of lime in the ligaments The condition commonly affects young males but its exact etiology is unknown although apparently active toxic foci in this part of the body may have some relationship

In the early stages the patient complains of muscle and joint pains Later his general condition deteriorates and he loses weight and gets increasing stiffness and deformity of the spine The sacro-iliac joints are usually the first affected there being osteoporosis in the early stages and, later sclerosis and ankylosis The whole spine becomes fused into a solid bony column and in the late stages the costo vertebral joints are equally affected with the result that only abdominal respiration is possible

Treatment is directed in the first place to obvious toxic foci which are eradicated. The pain is controlled by means of deep X-ray therapy This appears to have a very beneficial effect on the disease At the same time the optimum position for ankylosis is obtained by gradual reduction of the deformity by means of pillows under the dorsal region When the X ray treatment is finished and the deformity of the spine reduced as much as possible a certain amount of mobility may be preserved by regular exercises directed to the spinal movements Where the deformity is in severe flexion osteotomies of the spine have been suggested by Smith Peterson

Fibrositis

Fibrositis, or *lumbago* as it is commonly called occurs in both acute and chronic forms It is a non-suppurative inflammatory reaction of the fibrous supporting tissues of this part of the body Little is known of the etiology but it may be due to focal sepsis an error in diet some defect in metabolism or to climatic conditions Acutely tender areas in the erector spinæ or its attachments are found, and at these parts it is usual to find enlarged fibrositic nodules It is important however to exclude all other causes of low back pain before a diagnosis of fibrositis is made There is often an associated referred sciatica—a further manifestation of the presence of rheumatic disease

In regard to treatment the first thing obviously is to eliminate any of the possible etiological factors In the acute case the patient must be put to bed to ensure complete rest The bowels are

well opened, a light diet is prescribed and the patient is instructed to drink large quantities of bland fluid, this amounting to at least 4 or 5 pints a day The pain may usually be controlled by 10 gr each of sodium salicylate and sodium bicarbonate four hourly for a few days

Local treatment of the acute type consists of heat from an infra red lamp hot bottles or even from a hot iron In some cases where the condition is limited to a few localised tender areas infiltration with ½ per cent novocain is of value Twenty to 50 c.c may be used and the treatment followed by vigorous massage and active back exercises

LOW BACK PAIN ASSOCIATED WITH STATIC OR POSTURAL ERRORS

Postural errors, either habitual from occupation or from the presence of such abnormalities as weak feet or excessive weight form a large proportion of the cases of low back pain and as well as being probably the most frequent cause they are the most difficult to treat Postural strain is precipitated by certain occupations Surgeons and dentists who have to bend over their work for long periods are specially liable Another of the common causes is a sagging or protuberant abdomen which by its weight and its downward and forward pull tires out the muscles and leads to increased tension on the ligaments supporting the lumbar spine The obvious treatment for such a condition is reduction of weight and therefore of the size of the abdomen by dietetic methods combined with active exercises designed to increase the tone and control of the abdominal muscles Failing this the strain may to some extent be relieved by supporting the abdomen In fitting abdominal supports it should be borne in mind that the strain is not diminished if the belt is of equal width at the back and at the front To be of real benefit the support should extend well above and well below the lumbar spine while its abdominal width must be greater than that at the back.

Many cases of chronic back strain are caused by deformities of the feet or the knee The feet therefore should be carefully examined and abnormalities such as flat foot or valgoid deformity corrected.

LOW BACK PAIN REFERRED FROM OTHER REGIONS

Besides local causes backache may be due to errors in different regions Osgood discusses four types —

(a) General debility with mental or physical fatigue
(b) Gynaecological and genito-urinary lesions
(c) Neurological lesions such as spinal cord tumours
(d) Imperfect mechanical conditions in the lower limbs especially faulty posture of the feet as referred to above

In all cases where the etiology appears to be obscure these conditions have to be considered and eliminated

LOW BACK PAIN FROM A COMBINATION OF CAUSES

This is probably the most important feature in difficult and persistent cases. Numerous combinations occur, as, for example, postural strains with susceptible bodily form or with anatomical variations, or postural and traumatic strains superimposed on a pre-existing hypertrophic arthritis. Such a combination of errors demands a combination of methods of treatment.

WALTER MERCER.

CHAPTER L

DISEASES OF THE MUSCLES, TENDON SHEATHS AND BURSÆ

MUSCLES AND TENDONS

INJURIES

SUBCUTANEOUS INJURY—Contusions and sprains are due to falls blows or violent muscular effort They are commonly seen in men who are taking strenuous exercise after a period of inactivity without graduated training and are therefore common among athletes at the beginning of a season or in workmen beginning heavy work after a period of idleness The muscles chiefly affected are those of the back or lower limb and at the moment of occurrence the patient experiences a sharp stabbing pain The muscle is bruised or a few of its fibres are torn across and a hæmorrhagic effusion of varying amount takes place among the muscle bundles Active movement brings back the pain, but gentle passive movement is tolerated until the muscle is stretched there is tenderness over the site of the lesion

Treatment is directed towards relaxation of tension and immobilisation The limb is placed in that position which will best relax the injured muscle the whole area is firmly strapped with adhesive plaster and the patient kept at rest for five days The strapping is then removed the limb bandaged firmly and massage and electrical treatment given Sound healing must be obtained before any further strenuous exercise is allowed as otherwise a weak scar forms which predisposes to a condition of recurrent sprain.

Hernia of Muscle results from similar injuries the sheath being ruptured and the muscle fibres projecting through the gap thus formed It is occasionally seen in the biceps muscle of the arm and in the adductor muscles of the thigh. The opening is small, causes little interference with function and treatment is rarely needed If there is any incapacity the gap should be closed with a living suture of fascia lata or by a *fascial graft*

Dislocation of Tendons.—Tendons which alter their direction on passing over a joint are held in position by bands of fibrous tissue Dislocation of the tendon from its bony groove will occur when this band is ruptured as the result of a severe strain The tendons commonly affected are the peroneus longus the long head of the biceps and the extensors of the thumb The accident is accompanied by a sharp pain and a sense of weakness in the limb The tendon can be felt to

slip from its groove when the joint is moved and there is local tenderness over the ruptured band In long-standing recurrent cases the tendon can be felt or even heard to slip in and out of its groove

Treatment consists in reduction of the dislocation and immobilisation of the joint in the position of relaxation with a light plaster-of Paris bandage for four weeks This is followed by massage and graduated exercises and leads to a permanent cure The recurrent cases require an exposure of the tendon which is retained in its groove by a fascial or a periosteal graft

Rupture of a Muscle or Tendon is produced by a sudden violent contraction of the muscle The rupture occurs in one of four situations either in the muscle belly at its junction with the tendon in the tendon or at the attachment of the tendon to the bone

Rupture of a muscle is seen in men engaged in hard manual labour or during some form of athletic exercise It usually takes place at the junction of tendon and muscle and is due to violent ill balanced action applied suddenly The muscle belly itself may be torn but in such cases it has previously been weakened by disuse or localised disease *e.g* a gumma The muscle fibres contract and the gap is filled with blood clot If no operation is performed a broad scar forms which leads to loss of function and subsequently to contracture unless great care is taken to prevent it On examination the gap between the torn ends can easily be felt and it is increased in width when the muscle is made to contract while the muscle itself becomes rounded and more prominent Fluctuation may be detected in the gap from the presence of blood

Treatment consists in early operation when the blood is removed and the tear sutured. The limb is put up in a position allowing maximum relaxation of the affected muscle for seven days after which gentle massage and movements are begun If operation is refused the results are unsatisfactory as adhesions may form to surrounding structures whereby function is further restricted

Tendons are either torn from their insertions or ruptured. When the injury occurs the patient often imagines that he has been hit so sharp and so localised is the pain, and if running he may fall down. The condition is recognised by the gap in the normal position of the tendon produced by the retraction of the muscle and by the absence of the movement which it normally produces although the muscle itself can be felt to contract

Treatment is immediate suture the results of which are excellent The limb must be immobilised for five days after which massage and graduated movements are continued for two weeks

The following muscles and tendons are those most frequently ruptured —

1 The biceps muscle is ruptured at the junction with its tendon above the elbow The tendon itself may be torn from the radial tuberosity and the long head may rupture inside the shoulder joint especially if it is weakened by acting in an osteo-arthritic joint

2 The extensor tendons of the fingers are injured close to their

attachment to the base of the distal phalanges This condition is essentially associated with ball games and is very common in cricket when a fast moving ball hits the tip of the finger The base of the phalanx may be fractured at the same time but rupture of the tendon does occur apart from fracture Unless sound healing takes place the terminal interphalangeal joint is permanently flexed a condition known as mallet finger (p 1019) Treatment consists in immobilising the finger so that the metacarpo-phalangeal and proximal interphalangeal joints are flexed and the terminal interphalangeal joint fully extended. This position is maintained for three weeks and care taken to protect the finger from further injury for an additional three weeks

3. The sternomastoid muscle may be torn at childbirth leading to torticollis (see p 306)

4. The rectus abdominis muscle is occasionally ruptured during the spasms of contraction in tetanus and rarely by severe coughing

5 The erector spinæ muscles are torn as the result of a patient attempting to lift heavy weights The tear usually occurs in the lower dorsal and lumbar segments of the muscle Pain and stiffness in the back often persist for many months and adhesions may form, necessitating manipulation under an anæsthetic before a return to full movement is obtained This class of injury is a common cause of litigation under the Workmen s Compensation Act

6 The adductor longus and adductor magnus are occasionally injured during riding and ski ing The former muscle is partially detached from its pubic origin and the latter is torn from its insertion into the femur The injury to the adductor longus is apt to become a chronic recurrent one especially in middle-aged people who take short periods of active exercise in the midst of a sedentary life

7 The extensor quadriceps muscle of the thigh is ruptured by a sudden violent contraction of the muscle in an attempt on the part of the patient to regain his balance after a slip or fall. This type of injury may result in a fracture of the patella, a rupture of the muscle just above the patella or a detachment of the patellar ligament from the tibia The fractured patella is recognised by the presence of two or more fragments When the muscle is ruptured the patella is intact and is separated from the muscle by a wide gap through which the anterior surface of the femur can be felt If the ligament is detached from the tibia the patella is drawn up into the thigh and the contours of the bones of the knee joint can be easily identified beneath the skin Treatment of all these conditions is immediate operation at which the joint is cleansed of blood clot and the tear repaired by careful suturing The leg is placed in a divided plaster case or on a back splint and massage and faradism started on the third day Patients should not be allowed to walk for three weeks

8 The plantaris tendon is snapped by a sudden movement and from its close association with games this injury has been termed a "tennis leg The patient often thinks he has been struck by a stone in the back of the calf The leg becomes painful and swollen, active plantar flexion of the ankle increases the pain and within twenty four hours bruising appears in the popliteal space and in the back of the leg.

Firm strapping of the leg for seven days followed by massage rapidly relieves the symptoms The patient need not be kept in bed

9 The **tendo achillis** is sometimes ruptured in athletes and dancers at the beginning of training by sudden sharp movements Rapid return to function can be obtained only by suture of the tendon

Division of Muscles and Tendons in Open Wounds.—A muscle may be injured in a penetrating wound and if the damage is extensive a cavity is formed by retraction of the muscle fibres This will be filled by blood clot which is likely to become infected Such wounds should be carefully explored before the skin is sutured and if the muscle is damaged it should be sutured and the wound closed with drainage

The division of tendons is usually seen in the front of the wrist and in the fingers being the result of a clean cut with a knife or of falls on pieces of broken glass or china The condition is diagnosed by the loss of movement normally produced by the tendon in spite of the active contraction of its muscle and by the position in which the parts are held. When one tendon is severed its opposing muscle contracts and pulls the joints into the position of its full action for example if the flexor tendons of a finger are divided the extensors hold the finger in full extension After the injury the proximal end of the tendon *is retracted for a considerable distance by spasm of the muscle* whereas the distal end is lying in the lower surface of the wound or just inside its sheath

Treatment follows the general lines of wound technique It must always be borne in mind that other important structures such as nerves may be injured and the wound must therefore be explored to discover the exact extent of the injury If more than one tendon is severed, the corresponding ends of each must be identified and care taken to distinguish the end of tendon from that of a nerve Apposition is obtained by mattress sutures of silk or catgut introduced some distance from the cut end to prevent them cutting out The limb is then put up in a position allowing full relaxation of the affected tendon for ten days

When tendons are divided *inside* a synovial sheath it is considered unwise to attempt primary suture as the necessary exposure predisposes to infection in the sheath with resultant adhesions and fixation of the tendon. Some weeks later secondary suture is performed and the tendon surrounded with amnioplastin. The results in the past have been extraordinarily bad but recently splendid results are reported from America where a new method of uniting the tendon ends by very fine metallic wire is being tried out

Tendons are sometimes torn away from their attachment to muscles as the result of an injury in which a part of the body is dismembered. This is exemplified by avulsion of a finger which is produced by the digit being caught in the moving parts of a machine and wrenched from the hand The flexor tendons are torn away from their muscle attachment and remain attached to the finger Special attention to the danger of infection is needed for the tunnels occupied by the tendons in the hand and forearm fill with blood clot and infection may ascend from the wound

INFLAMMATORY DISEASES OF MUSCLE

Simple Myositis follows minor injuries which bruise the muscle fibres Pain on movement and localised tenderness persist for a few days

Acute Suppurative Myositis.—Infection may reach the muscle by direct implantation in penetrating wounds by extension from a neighbouring focus and by metastasis in pyæmia. The muscle becomes painful swollen and tender and all movements increase the pain If drainage is not established pus will track rapidly throughout the limb

Treatment is by incision and drainage

Chronic Myositis.—**Tuberculous Myositis** occurs only as a complication of tuberculosis of neighbouring structures The psoas muscle is involved in spinal caries and the sternomastoid is invaded by the spread of infection from cervical glands In the former case the pus tracks down the whole length of the muscle inside its sheath but in the latter a localised induration appears and this may break down into a small abscess

The *treatment* is directed primarily to the cause

Syphilitic Myositis is of three types Firstly in the secondary stage transient pain and tenderness may affect one or more muscles secondly early in the tertiary stage a diffuse fibrosis may arise insidiously in several members of a group of muscles leading to stiffness and finally to contractures thirdly later in the tertiary period localised gummata may occur in any individual muscle those of the tongue and the sternomastoid being common examples A gumma forms an indurated rounded swelling which is neither painful nor tender and which eventually involves the surface epithelium and leads to the typical ulcer The history of the original infection, the Wassermann reaction and the response to treatment establish the diagnosis

Actinomycosis attacks muscles only by invasion from the primary lesion. The masseter pterygoid muscles and those of the tongue chest and abdominal walls are chiefly affected

Toxic Myositis—usually called muscular rheumatism —is a common complaint among men and women after thirty years of age and is due to a toxin derived from a focus of infection in the teeth tonsils air passages or intestinal canal It also affects the muscle sheaths fasciæ ligaments and nerves and is probably a neurofibrositis rather than a myositis The best-known example is "Lumbago," in which the lumbar aponeurosis and the erector spinæ muscles are involved In severe cases the pain is of sudden onset and movement is a painful and laborious process Exposure to cold draughts gives rise to a stiff neck, which is another n example of this condition

Treatment co hot application by radiant heat
short wave diat massage Eve ould be made to
discover and era ocal sepsis tha

Parasitic My ainful code ling of muscles
particularly those arm due t ce of the e
of the Tr k na s 32)

Myositis Ossificans is a rare disease with a familial tendency affecting young males. The pathology is obscure but it is possibly a primary fibrositis leading to atrophy and replacement of the muscle fibres. The condition starts in the muscles of the back and flat plaques or rods of bone are laid down irregularly and without attachment to the bones of the part. It is a slowly progressive disease and spreads to other groups of muscles. The movements of the body become increasingly difficult and death from asphyxia follows the immobilisation of the respiratory muscles. Pain is not a prominent symptom. No treatment is of any avail.

Myositis Ossificans Traumatica is the result of an injury in the region of joints. A fracture or a tear in the periosteum may be in close proximity to the origin or insertion of a muscle. Under certain conditions the bone forming process spreads up the tendon or aponeurosis into the muscle belly and a bony mass of considerable size may form (Fig. 625). The process may be initiated or aggravated by too early attempts at movement. It is met with most frequently in connection with fractures near the elbow joint in children, the brachialis anticus being chiefly affected.



Fig. 625.
X-ray showing myositis ossificans traumatica in the brachialis anticus muscle.

The *treatment* entails complete immobilisation in a plaster-of-Paris case for many weeks until the greater part of the newly formed bone is reabsorbed. If any serious interference with movement remains after one year the bony mass should be removed.

A more chronic type is due to repeated slight trauma and is exemplified by the ossification of the tendon of the adductor longus muscle above the knee—the so-called "Rider's bone". No treatment is needed unless symptoms are present, which is unusual.

Myositis Fibrosa, also known as ischæmic paralysis or **Volkmann's contracture,** is the result of too tight bandaging, of pressure from ill-applied splints or of too prolonged use of a tourniquet; it may be due to damage to the brachial artery directly at the time of injury. It is usually associated with fractures near the elbow and affects the muscles in the forearm. As the result of pressure the brachial artery is compressed and the muscles are starved of blood, undergoing a process of autodigestion termed necrobiosis. The muscle fibres are replaced by fibrous tissue, the contraction of which leads to the deformity of the hand. The severity of the damage to the muscles varies considerably in different patients. The symptoms usually pass unnoticed until the splint is removed, the complaints of pain and a feeling of tightness in the limb being ascribed to the fracture. When the splint is removed, the patient notices that he is unable to use his fingers and it will be seen that they are flexed at the phalangeal and metacarpo-phalangeal

joints. If the wrist is fully palmar flexed the fingers can be straightened, but when the wrist is moved into full dorsiflexion the fingers become progressively more flexed. There is limitation of supination of the forearm owing to contracture of the pronator radii teres The differential diagnosis rests between Volkmann's and Dupuytren's contractures lesions of the ulnar median and musculospiral nerves and deformities of the hand due to sepsis The extension of the fingers when the wrist is flexed, the absence of anæsthesia and of the reaction of degeneration should serve to settle the diagnosis

Treatment is essentially prophylactic Careful attention to detail in the management of fractures should eliminate this condition and if during the first few days the patient complains of pain and tightness of the bandages the splints must be thoroughly investigated and removed entirely if any doubt exists The radial pulse beat at the wrist is an excellent indicator of arterial obstruction and if it is of much smaller volume on the injured side the splints should be removed Established cases are treated by graduated movement on an adjustable splint which has a hinge at the level of the wrist and a racket for varying the angle The forearm hand and fingers are fixed in the splint in a position of full flexion of the wrist thus allowing the fingers to straighten. The angle of flexion at the wrist is decreased daily by the screw the fingers being firmly fixed in extension. In this way the muscles are slowly stretched and finally the fingers can be kept extended even when the wrist is dorsiflexed The more advanced cases will not respond to this method and Max Page's operation should be performed This consists of stripping the common origin of the flexors and allowing them to gain fresh attachments lower in the forearm. The results of this condition are deplorable and it must be emphasised that it is preventable

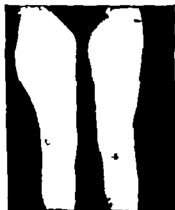


FIG 626

A large sarcoma arising in the muscles of the right thigh in a young woman.

TUMOURS OF MUSCLES

Benign Tumours.—The only benign tumour which arises from muscle is the rare rhabdomyoma which has been recorded in the tongue Leiomyoma is common in the uterus but always contains fibrous tissue Other benign tumours in muscle are lipoma angioma, fibroma and fibromyoma.

Malignant Tumours.—A pure muscle sarcoma does not exist, though it may be a constituent of a teratoma but a spindle-celled fibrosarcoma arises in the connective tissue of muscle It shows a marked tendency to spread throughout the muscle and to refrain from infiltrating its sheath and invading neighbouring structures The muscle becomes enlarged and hard and stands out prominently from its neighbours (Fig 626) This type of growth is met with not infrequently in

the hamstring muscles The rate of growth and the consistency of the tumour vary but they are relatively slow-growing The swelling cannot be moved in the long axis of the muscle fibres but can be from side to side There is usually little doubt as to the diagnosis and a sarcoma is distinguished from diffuse gummatous infiltration by remaining localised to one muscle instead of affecting several members of the same group

Treatment in the early stages consists of complete excision of the whole muscle but in the later stages amputation will be necessary and it must be so planned as to remove entirely all the affected muscles

The electrical reactions of muscle and the methods in use for eliciting them are described on p 038

DISEASES OF FASCIA

DUPUYTREN'S CONTRACTURE OF THE PALMAR FASCIA

The middle division of the palmar fascia extends from the distal margin of the anterior annular ligament and spreading out in a fan shaped manner affords a protective covering to the flexor tendons nerves and vessels in the palm At the base of each finger a digital prolongation is formed which fuses with the sheath of the flexor tendons and sends a process on each side of the finger to blend with the deep fascia in its lateral aspects

Etiology—Dupuytren's contracture affects this middle division of the palmar fascia, and occurs in men in later life as a result of long continued pressure in the palm It is traditionally reputed to be due to gout but the association lies in the use of a stick as an aid to walking when the big toe is affected by this complaint It is not uncommon in the hands of skilled craftsmen carpenters and mechanicians *e.g* the line repairer in the telephone and telegraph service is apt to suffer from contracture in his left palm by which he supports himself while working mainly with his right

Pathology—A thickened indurated nodule first makes its appearance in the palm at the level of the distal flexion crease at the base of the ring finger The skin is also thickened and firmly attached to the fibrous nodule beneath. Very slowly the induration spreads distally in the fascia towards the ring and little fingers and still more gradually proximally up the palm In many patients the process does not extend across the palm but in others the middle and rarely the index fingers may be affected.

The Clinical Picture is unmistakable The contraction of the fibrous processes leads to flexion of the metacarpo-phalangeal and proximal interphalangeal joints so that slowly the ring and little fingers are flexed into the palm. The terminal phalanx usually remains extended After many years the flexion may become so advanced that the fingers can hardly be separated from contact with the palm

If treatment is not adopted in the early stages the skin also becomes contracted and hypertrophied across the front of the flexed joints

Treatment —Although a number of operations have been advised, nothing short of radical removal of the fascia should be contemplated. So closely adherent is the skin to the underlying fascia that its nutrition may be badly damaged during operation and in many patients a plastic pedicle skin graft will be needed to re form the covering of the palm The dissection must be carried into the fingers as it is essential that the digital prolongation should be completely removed as well as the parent fascia in the palm

It is important that treatment should be undertaken before the contracture has been allowed to advance too far

Other diseases of fascia are dealt with elsewhere toxic or rheumatic conditions under toxic myositis (p 1214) and gonococcal fibrositis and fasciitis in the chapter on Venereal Disease (p 60)

THE TENDON SHEATHS

TENOSYNOVITIS

Acute Non-suppurative Tenosynovitis commonly occurs in the sheaths of the extensor tendons of the thumb and of the peroneal tendons at the ankle It is usually the result of over use following a period of inactivity and is therefore met with in men resuming heavy manual work after enforced idleness in seamstresses and in both sexes at the beginning of a season of golf or tennis The lining membrane becomes swollen and the sheath is filled with a serous effusion The patient complains of pain during certain movements and a narrow elongated swelling is present in the position of the sheath, which is slightly tender Movement produces a characteristic fine creaking which disappears if the sheath becomes very distended and reappears as the effusion is absorbed

Treatment consists of firm strapping over the lower part of the forearm and wrist and resting the arm in a sling for one week, after which massage and diathermy quickly complete the cure

Chronic Tenosynovitis follows repeated attacks of the acute condition The part should be immobilised for fourteen days and then counter irritation, passive congestion ionisation and massage should be tried The condition is apt to be resistant to treatment

Acute Suppurative Tenosynovitis may affect any tendon sheath but is most frequently seen in the hand as a complication of septic fingers Its results are so crippling if imperfectly treated that the condition is described in full in the chapter devoted to infections of the hand (p 231)

CHRONIC TUBERCULOUS TENOSYNOVITIS

The sheath may be the primary seat of the condition or it may be involved from a neighbouring joint It affects either sex occurs at any age after puberty and is usually seen in the sheaths around the wrist and ankle Two distinct varieties occur the fluid and the dry

The **fluid type** is the commoner and is characterised by a fluid effusion into the sheath the endothelial lining of which becomes moderately thickened Fibrin is deposited on its surface and flakes of it are detached by movement of the tendon These are moulded into small flat elliptical bodies named "**melon seed bodies.**" At operation the sheath is tightly packed with them and in the fresh state they are pearly white semi translucent flakes This type of affection remains confined to the sheath and does not spread into the surrounding skin bones or joints Clinically there is a narrow elongated swelling in the whole length of the sheath in which fluctuation can be obtained The melon-seed bodies give a granular feeling and a fine creaking on movement

This condition affects the sheaths of the flexor tendons at the wrist and spreads throughout the ulnar and radial bursæ and into the sheaths of the finger and thumb It is known as the "**compound palmar ganglion,**" in which the swelling is bi lobed the anterior annular ligament dividing it into a pouch above the wrist and another in the palm between which cross fluctuation is obtained (Fig 627)



Fig 627
A compound palmar ganglion.

Treatment may be conservative or radical The conservative method entails immobilisation of the limb in a plaster-of Paris bandage for three months If marked improvement is shown at the end of this time general treatment can be continued with confidence in the eventual result but if little or no improvement is achieved then operation should be performed. Radical operative treatment is advocated by many surgeons at the outset and Kanavel is of the opinion that *open operation* in compound palmar ganglion yields much superior results The sheath is opened in its whole length the melon-seed bodies removed the tendons freed from their fibrinous covering and the thickened lining of the sheath dissected away The wound is *closed without drainage* and placed in a plaster splint with the wrist *in the dorsiflexed position* From a considerable experience I am convinced that operation is definitely the best treatment furthermore the earlier that operation is performed the more perfect will be the final functional result

In the **dry type** the synovial membrane is thickened œdematous and

infiltrated with tuberculous granulation tissue which spreads on to the tendons and involves the adjacent bones joints and subcutaneous tissues Caseous foci develop and coalesce to form abscesses and if the skin becomes involved the pus is evacuated, a chronic sinus remaining In the early stage there is a doughy swelling of the sheath, which later becomes more diffuse and fluctuant Movements are painful and limited

Treatment consists in operation at the earliest possible opportunity but the results are less satisfactory than in the fluid type

Syphilitic Tenosynovitis is rare In the secondary stage there may be a transient serous effusion and in the tertiary stage a painless gummatous thickening The history and the Wassermann reaction lead to a correct diagnosis and the condition yields readily to antisyphilitic treatment

Gouty Tenosynovitis is occasionally seen in the fingers and hand and leads to the deposition of large masses of sodium biurate (tophi)

TUMOURS OF TENDON SHEATHS

A Ganglion is an encapsuled cystic swelling arising from the synovial membranes of joints and tendon sheaths Its true pathology is not understood In the past it was described as a hernial protrusion of the synovial membrane through the fibrous sheath or capsule This is certainly incorrect and it is probably a myxomatous degeneration of the subsynovial tissues or a pure myxoma. It consists of a fibrous cyst filled with a glairy jelly like fluid The commonest situations are the dorsum of the hand and wrist (Fig 628) the peroneal region of the ankle the anterior surface of the wrist and the bases of the fingers on their flexor aspect. Recurrence after removal is admittedly frequent because it is not recognised that the majority of ganglia arise from the subsynovial tissue of joints and not from the tendon sheaths this is especially true of those on the dorsum of the wrist The chief symptom is the appearance of the swelling but for several days before this is apparent some patients complain of dull aching pain and the wrist feels weak When a ganglion is small it is so tense that it may be mistaken for a solid even bony tumour but later it is fluctuant and translucent It is fixed to the deeper structures but the skin moves freely over it



Fig 628
A simple ganglion on the back of the hand.

Treatment —It has been observed that accidental rupture has sometimes led to a lasting cure The ganglion may be ruptured deliberately by pressure a blow or by slitting its capsule with a fine tenotome the fluid being then expressed into the subcutaneous tissues and the part firmly bandaged A certain number appear to be cured by this method Aspiration and injection with sodium morrhuate have been given a trial but yield unsatisfactory results and are not devoid of risk The method of choice is excision and the ganglion must be removed completely or recurrence will follow The

dissection should be carried down to the joint capsule and not stopped short at the tendon sheaths

The compound palmar ganglion has been described above

New Growths are rare Subsynovial lipoma hæmangioma fibroma endothelioma and sarcoma are described The so-called myeloma of tendon sheaths (Fig 629) is not infrequently met with in connection with the fingers It is a soft spherical tumour with a definite capsule and in naked-eye appearance and histological structure it corresponds closely to the xanthoma being of golden yellow

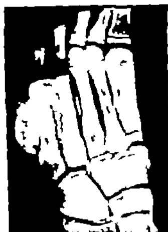


Fig 629
A myelo-xanthoma of the foot of such long standing that calcification is present.



Fig 630
Section of a my lo-xanthoma of a t ndon sheath. (Kettle.)

colour and containing lipoid material (Fig 630) It is benign and local removal suffices

DISEASES OF BURSÆ

Bursæ are of three varieties True bursæ are interposed between two moving surfaces to reduce friction or are placed over prominent bony points to act as protective cushions (*e.g* the ischial and olecranon bursæ) Bursal extensions of joints fulfil a similar function but are continuous with the synovial membrane of the joint Adventitious bursæ are developed in situations in which bony prominences are subjected to pressure (*e.g* the bursa over the head of the metatarsal in hallux valgus that over an exostosis or those in connection with the carrying of weights on the shoulder) In structure all bursæ consist of a fibrous capsule lined with endothelium analogous to the synovial membrane of joints

INJURIES TO BURSÆ

Wounds.—Bursæ are opened by incised or punctured wounds or by falls in which the overlying skin is split The injury is recognised

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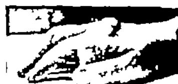


FIG. 928

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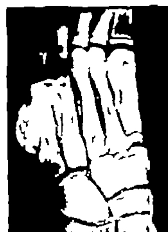


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FIG 630

Section of a myelo-xanthoma of a tendon sheath. (*Keith*)

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INJURIES TO BURSÆ

Wounds.—Bursæ are opened by incised or punctured wounds or by falls in which the overlying skin is split The injury is recognised

by the escape of synovial fluid, and if this persists—as it sometimes does—the bursa must be removed.

Acute Traumatic Bursitis follows a contusion. The bursa becomes distended by a blood-stained serous effusion and is prominently enlarged and tender The overlying skin may be bruised but the signs of inflammation are absent The parts should be kept at rest by firm strapping the fluid having been first aspirated if the collection is of any size

Chronic Traumatic or Serous Bursitis is the commonest disease of bursæ and is the result of repeated slight trauma. A chronic serous effusion occurs as a result of which the walls become thickened by the deposition of layers of fibrin and by fibrosis At first there is a considerable amount of fluid present but later the progressive thickening of the walls leads to a reduction in the size of the cavity to a mere cleft The condition is then termed a chronic fibroid bursitis Excision of the bursa is the only satisfactory treatment



Fig 631
An acut suppurative bursitis of the prepatellar bursa, which has been llowed to progress without treatment.

Hæmorrhagic Bursitis is an occasional result of injury the bursa being distended with blood It may be met with in certain blood diseases such as hæmophilia and leukæmia Treatment consists in firm strapping and rest

INFLAMMATORY DISEASES OF BURSÆ

Acute Suppurative Bursitis follows incised or punctured wounds and is staphylococcal in origin In some cases the infection is carried to the bursa by the lymphatics from a septic focus in the vicinity when it may be either staphylococcal or streptococcal. Although the infection is primarily limited to the bursa pus readily spreads through the capsule and an acute cellulitis results (Fig 631) In neglected cases the underlying bone or joint may be involved. Treatment consists in free incision and drainage and if later a sinus persists the bursa must be excised Chemotherapy should be instituted immediately the diagnosis is made

Tuberculous Bursitis is similar to tuberculous tenosynovitis in being of two types the fluid and the dry The infection may be primary in the bursa or it may spread from a joint with which the bursa communicates The fluid type is characterised by an effusion and melon-seed bodies while the dry tends to caseate and form an abscess Treatment depends on the anatomy of the affected bursa those which are unconnected with a joint should be excised, whereas the others share in the appropriate treatment for the tuberculous joint

Syphilitic Bursitis is sometimes seen in the secondary stage in the form of a transient effusion In the tertiary stage it usually affects the ischial and prepatellar bursæ is frequently bilateral and occurs as a diffuse gummatous infiltration. Ulceration through the overlying skin is liable to follow Chronic bilateral bursitis should always suggest the possibility of syphilis and the history the Wassermann reaction and the rapid response to specific treatment confirm the diagnosis Treatment follows the usual antisyphilitic routine


FIG 632
Bilateral olecranon bursitis.

Gonococcal Bursitis is one of the complications of gonorrhœa (see p 60)

Gouty Bursitis is similar to gouty tenosynovitis sodium biurate being deposited in the wall of the bursa Large swellings result and the skin may give way leading to a gouty ulcer The olecranon bursa is commonly affected The mass should be excised

INDIVIDUAL BURSÆ

Group I.—The True Bursæ

1 The subdeltoid bursa lies between the deltoid muscle and the underlying great tuberosity of the humerus It may be the seat of an acute gonococcal infection particularly in women and of chronic tuberculous disease It forms a fluctuant swelling beneath the muscle and active abduction is painful and limited


FIG. 633
A typical example of "housemaid's knee."

2 The olecranon bursa may be acutely infected by wounds or by lymphatic infection from sepsis in the forearm or hand Chronic serous bursitis (Fig 632) is common in certain types of people and is termed the miner's or student's elbow It is also the seat of gouty deposits

3 The ischial bursa is met with in people whose work entails prolonged sitting and has long been known as the weaver's bottom It may be affected in tertiary syphilis

4 The gluteal bursa lies between the tendon of the gluteus maximus and the great trochanter of the femur and is occasionally affected by tuberculosis It appears as a swelling behind the trochanter and causes abduction and eversion at the hip joint

5 The prepatellar bursa is the most commonly affected by all types of disease particularly as the chronic serous bursitis or housemaid's knee (Fig 633)

6 The bursa between the ligamentum patellæ and the anterior surface of the upper end of the tibia is occasionally the seat of a chronic serous effusion and more rarely of an acute infection It gives rise to a fluctuant swelling on either side of the ligament and to discomfort when the knee is straightened If it becomes acutely infected it must be drained immediately lest the knee joint be secondarily infected

7 The tendo achillis bursa is chronically enlarged as the result of pressure from ill fitting shoes. It presents as a fluctuant swelling on either side of the tendon



FIG. 634
A large adventitious bursa over the left shoulder

Group II.—Bursæ Communicating with Joints.

8 The semi membranosus bursa lies between the semi membranosus tendon and the inner head of the gastrocnemius muscle and has a narrow opening into the postero-internal aspect of the knee joint Its enlargement therefore may be secondary to disease of that joint and this must be carefully considered and excluded before the removal of the bursa is advised Chronic serous bursitis is frequent among children of both sexes and may be bilateral. The swelling is more prominent and more tense in full extension of the joint Treatment consists in dissection of the sac and ligation of its neck at its entrance to the joint.

9 The popliteus bursa communicates freely with the knee joint and is rarely enlarged except as a result of disease of the knee

10 The psoas bursa is frequently in communication with the hip joint but in some people is a separate sac It lies between the psoas tendon and the hip joint When it opens into the joint it participates in its diseases in other cases it is occasionally the seat of a chronic serous bursitis, which is often bilateral. It forms a swelling in Scarpa's triangle and is tense in extension and flaccid in flexion of the hip

Group III.—Adventitious Bursæ.

These are of new formation over bony prominences subjected to constant pressure for example —

(a) The deal runner's shoulder (Fig. 634)
(b) The Covent Garden bummy over the 7th cervical vertebra.
(c) The basket carrier's bursa in the scalp
(d) The tailor's ankle a bursa over the external malleolus
(e) Those over exostoses hallux valgus and deformed feet

R M HANDFIELD-JONES

CHAPTER LI

AMPUTATIONS

AMPUTATIONS provide at one and the same time some of the most dramatic and some of the most distressingly destructive operations in the whole of surgery As surgical procedures they date far back into history and for a fascinating description of this aspect of the subject one cannot do better than refer the reader to a delightful article by Gordon Taylor in the *Transactions of the Medical Society of London* (vol. lxiii 1942) Major amputations in civilian life are relatively few and far between but the evil impetus of war especially a so-called modern war produces a veritable host of limbless victims Luckily for them and to the great benefit of posterity this temporary vast increase in the number of amputations has led to very considerable advances in the technique of and a far more practical appreciation of the principles which should govern amputations In general the trend has been to simplification combined with much closer co-operation between the surgeon and the artificial limb-makers (both limb making surgeons and technicians) Although final figures are not yet available it is worthy of note that this recent Great War has produced something less than half the numbers of limbless that the first Great War did Many interesting factors contribute to this result the chief being probably the mobility of modern warfare and the advent of chemotherapeutic and antibiotic agents preventing dangerous sepsis On the other side of the ledger should be put the fact that owing to large-scale aerial warfare the numbers of amputations performed on women and children has increased out of all proportion

Briefly the indications for amputation may be stated as

1 **Trauma** (if excessive and involving the main vascular supply of a limb—including major burns)

2 **Congenital Deformities** (if excessive and irremediable by modern orthopædic methods)

3 **Infection** (if excessive)

(*a*) *Acute*—particularly in cases of streptococcal and gas gangrene infection where initial treatment has been delayed

(*b*) *Chronic*—old-standing or neglected infection (*e.g* tubercle of bones and joints trophic ulceration) especially if amyloid disease is threatened or present

(Both these groups thanks to modern surgical methods and chemotherapy *should* now produce only minimal numbers of amputations)

4 **Vascular Gangrene**

5 **Malignant Growths**

The principles governing amputation may be summarised as

1 **The Production of a Sound Stump.**—This is the surgeon's responsibility and involves the selection of the optimum site for amputation, the careful formation of suitable flaps (both of which demand experience and close liaison with the limb maker) and the judicious treatment of important structures within the stump e.g major nerves vessels and bones. Such methods therefore aim at the production of a lever of optimum length capable of taking a modern artifical limb and a stump closed by a well healed, freely mobile and painless scar and possessed of an adequate blood supply Few stumps now have to be weight bearing in those below the knee weight is taken on the tibial tuberosity and above the knee on the ischial tuberosity Despite this fact the terminal end of all stumps are liable to irritation and infection—complications which may jeopardise the whole result of the amputation Every case must therefore be treated on its individual merits

2 **The Manufacture and Fitting of an Artificial Limb.**—This is the responsibility of the limb-making surgeons and technicians and involves suitable post-operative moulding of the stump the production of a limb the consistency and mechanism of which provides function as nearly normal as possible and the training of the patient both physically and psychologically in the correct use of his prosthesis It will be seen from this and it cannot be stressed too often how essential is complete co-operation between all concerned—patient, surgeon and limb-maker

Methods of Amputation

For all practical purposes all amputations are to-day performed by one method only—that of *flaps* This is in fact a very old one an Exeter surgeon in 1679 having the credit of first using the method. The flaps are usually anterior and posterior but can if necessary be lateral or intermediate between these two positions Again they are to-day as a rule made of equal length but there is no radical objection to unequal flaps in which case the anterior is usually the longer In equal flaps the length of the flap should be just slightly greater than the diameter of the limb at the proposed site of bone section In these days of chemotherapy the cutting of longer flaps to cope with ultimate contraction of the scar from expected secondary infection should be frowned upon—except where circumstances demand amputation in the presence of frank sepsis Flaps should be rectangular or broad U-shaped and include skin subcutaneous tissue and in certain situations a little muscle

Other methods which still have a limited application or historical interest are

(a) **Circular**

(i) *Guillotine* A circular cut around the limb through all tissues including bone Now entirely given up in this country it was for some reason the routine method in the German Army in the recent war Results were deplorable

(ii) *Cuff*.—A circular cut through skin and subcutaneous tissue which layers are then pulled up to be followed by a circular cut through muscle at a higher level this in turn being drawn up to allow bone section at a still higher level This leaves a bulky cumbersome stump with usually a puckered indrawn attached scar and is also practically obsolete

(*b*) **Transfixion.**—When the knife is plunged through the soft tissue of the limb and drawn from within outwards This method is still used (after skin flaps have been fashioned) in areas where tendons predominate over muscular tissue—particularly in the forearm

(*c*) "**Racquet.**"—The name is self-descriptive and is used in amputations of digits and to a lesser extent in hip and shoulder amputations (Fig 635)



Fig. 635
Disarticulation through the hip joint by means of an anterior asymmetrical racquet.

VARIETIES OF AMPUTATIONS

1 **Congenital.**—This is really a misnomer Originally it was thought that the absence of part of a limb at birth was due to "amputation" by amniotic bands *in utero* Nowadays it is realised that these abnormalities are due essentially to an inherent growth defect in the foetus

2 **Disarticulation.**—Implies the removal of a limb or part of a limb through a joint *i e* without actual bone section Except perhaps in the case of the digits disarticulations have become increasingly unpopular They leave a stump to which it is extremely difficult to fit a suitable artificial limb In the recent war it was only in cases of dire emergency (*e.g.*, when the major limb injury was accompanied by an abdominal thoracic or cranial wound) that disarticulation was permitted in preference to a planned amputation

3 **Primary and Secondary**—In primary amputation the whole operation is planned and completed in one sitting In the presence of gross sepsis (particularly with gas gangrene organisms present) the flaps after removal of the damaged or diseased limb are left wide open

and either sutured at a later date ("delayed" or secondary suture) or a further (secondary) amputation is performed with the old flaps and bone suitably trimmed and the former sewn up In the first stage it is wise at the end of the operation to draw the soft tissue down by adhesive plaster strips attached to a ring from which a suitable weight is suspended.

Technique of Amputation

As has been stated earlier in this chapter the tendency to-day is all towards simplification and standardisation of amputations Certain special amputations require brief description certain historical amputations a mention, but the great bulk of amputations can now be classified as either Above or Below Knee and Above or Below Elbow " These will be described in more detail later but the following technique applies to all. The limb should be elevated as perpendicularly as possible in order to drain from it the maximum amount of venous blood. After a few minutes and while still in this position a tourniquet is applied (over a towel) as high as possible in the groin or axilla The site of operation is prepared and towelled off in the usual manner Skin flaps are then marked out according to a pre-arranged plan and incisions made delineating them through skin and subcutaneous tissues, bearing in mind that both too short and too long flaps have obvious drawbacks. The tension of the former and the flabbiness of the latter both offer invitations to sepsis, adherence of the scar and subsequent discomfort. The skin flaps are turned back and the muscles cut through slightly obliquely down to the bone at the selected site of section remembering that flexor groups have a greater tendency to retract than extensors. A certain amount of muscle tissue in a stump allows good moulding for the bucket of the artificial limb but excessive soft tissue giving a bulbous end is to be avoided As muscles are cut through main vessels and nerve trunks will be identified and should be caught in artery forceps The soft tissues are now retracted up and down and a cuff of periosteum raised for an inch to the proposed site of bone section The bone or bones are then sawn across and the limb removed. Any sharp edges of bone *e.g* the anterior border of the tibia and perhaps the linea aspera of the femur are bevelled off either with a saw or bone forceps In the leg the fibula should be sectioned a good inch proximal to the site of tibial amputation The stump is inspected and obvious vessels caught The tourniquet is now released and any further vessels (chiefly muscular) secured All vessels are ligated main nerves are drawn well down and cut without ligature and without injection of local anæsthetic A few deep catgut sutures are then inserted to draw the muscle groups together over the bone end which should already be covered by the periosteal cuff The skin flaps are approximated by interrupted sutures and a drain placed in the most dependent part of the wound. (This can usually be done and should be removed after forty-eight hours) A generous dressing of gauze and wool is then applied and fixed either by strapping or bandaging The use of a plaster-of Paris cap over an amputation dressing is favoured by some surgeons.

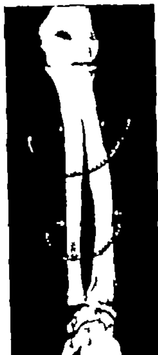


Fig. 636
Amputations through the forearm

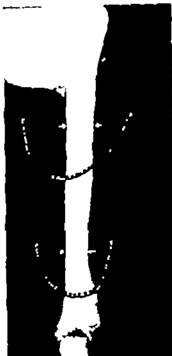


Fig. 637
Amputations through the upper arm.

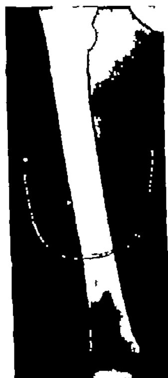


Fig. 638
Amputation through thigh. The level may be raised to suit the demands of each individual case.

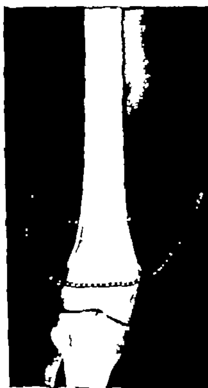


Fig. 639
The modern "above knee" operation. Point of bone section indicated by arrows.

straightforward case it should be possible to-day to fit an artificial leg within three months and an arm within two months of amputation. This period, if properly used, is invaluable not only in training the patient to full and correct physical use of his stump but in engendering as far as possible the right mental outlook on his future. The importance of this rehabilitation—both physical and psychological—cannot be overstressed. In this connection two practical points should be noted: firstly, that the younger the patient the better is he likely to adjust himself to his new circumstances, and secondly, that arm amputees are as a rule much more loath to accept their artificial limb than those who have lost a leg.

Stump Complications.

1. Sepsis
   (a) Soft tissues
   (b) Bone necrosis
2. Sloughing of flaps
   (a) From tension (too short)
   (b) From avascularity (too long)
3. Conical stumps arise from the making of too short a stump, from sepsis with subsequent fibrosis and contraction, and in children in whom the bone continues to grow. Re-amputation is often called for in these cases.
4. Pain
   (a) From "stump neuroma" of a nerve trunk improperly dealt with at the time of amputation.
   (b) From an adherent scar with nerves involved.
   (c) From a bone spur.
5. Adherent scar giving pain, skin irritation, dermatitis and even abscess formation.
6. Phantom limb } Largely avoided by strict post-operative
7. Muscular spasm } rest.
8. Muscular contractions.
9. Causalgia.
10. Vasomotor disturbances.

Sites of Amputations

These can be conveniently grouped under the headings:
(a) Standard.
(b) Special.
(c) Historical.

(a) **Standard Sites.**—As stated previously these include the great bulk of major amputations and consist simply of "Above or Below Knee" and "Above or Below Elbow". In general they are all carried out according to present-day practice by the flap method (equal anteroposterior flaps) and by the technique described above.

1. *Above Knee.*—The optimum site for bone section is 10 to 1[illegible] the tip of the great trochanter. Anything longer (like

Its great use was in war when these cases had often to be transp long distances after their primary operation and the cap pre painful traumas whilst in transit

After treatment.—(*a*) *Immediate.*—On the return of the pati bed the stump should be elevated on a pillow or sand bag Any should be dealt with by the application of further wool firmly bar

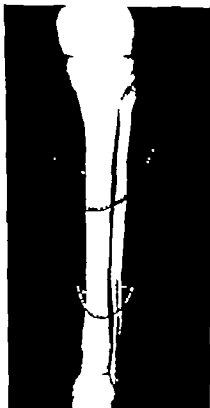


FIG. 640

The modern below knee amputation. That at the higher level is the "amputation through the site of election" The lower is not to be recommended as it is poorly nourished st mp with thin covers.



FIG. 641

The classical Syme amputat

or strapped over the o dressing Early movement c stump should not be encour It tends to produce painful m spasms and to intensify that bear of the recent ampu case—the phantom limb C movements may be started on removal of the stitches (abou eighth to tenth day) and full active movements only when the w is soundly healed and dressings can be discarded (about the third w

(*b*) *Later.*—At this stage the limb maker should be called in the stump carefully bandaged with crepe bandage in order to m it to the correct shape for the artificial limb Once this applied the patient should be allowed up and encouraged crutches The use of an interim pylon leg between amp fitting of a definitive artificial limb has fallen out of

the old supracondylar amputations and knee disarticulation) tends to produce a stump which is both an unwieldy lever and prone to circulatory troubles A satisfactory limb can be fitted to a stump as short as 6 in but above this a tilting table prosthesis becomes necessary In this latter class an amputation through the femur at the level of the lesser trochanter is preferable to a disarticulation at the hip

In these above knee amputations an anterior flap slightly longer than the posterior is accepted as good technique (Fig 639)

2 *Below Knee.* —The optimum length of tibia is 6 in measured from the tibial tuberosity the minimal length allowing a useful limb is 2½ in. It will be remembered that the fibula is sectioned an inch higher than the tibia and that the anterior border of the latter is bevelled off Flaps are equal anteroposterior (Fig 640)

3 *Above Elbow* —Optimum site for bone section is 8 in. from the tip of the acromion. It is possible to have too long a humerus lever and in general no amputation in this area should be less than 3 in above the elbow Flaps are equal, anteroposterior

4 *Below Elbow* —Optimum site for bone section is 7 to 8 in from the tip of the olecranon An amputation about this level is infinitely preferable from a functional point of view to disarticulation at either wrist or elbow An artificial arm can be fitted to as short a forearm stump as 3½ in. but amputations proximal to the insertion of pronator radii teres are not usually satisfactory

(*b*) Special Sites.—1 *Fingers and Hand* —Methods used in this area are described in a separate chapter (see p 230).

2. *Toes* —Methods used are in all respects similar to those used for the fingers

3 *Syme's Amputation* —Syme originally described his method over one hundred years ago To-day considerable controversy still centres around it In this country the majority of surgeons and practically all limb makers prefer the standard below knee amputation but in the United States and in Canada Syme's amputation is still very popular in suitable cases Its great advantage is that it provides a weight bearing stump on which the patient can get about without the aid either of an artificial limb or of crutches a most important consideration in the case of such men as agricultural labourers Its chief disadvantage is that the terminal end of this stump consists of fibro-fatty tissue which at the best of times has not a very good blood supply and which being subjected to constant wear and tear is prone to vascular trophic changes It consists of an amputation through the tibia and fibula just above the ankle joint—the pad of the heel being swung up in a plantar flap to form the end of the stump The incision extends from just below the external malleolus to ½ in below the internal malleolus and slopes slightly back towards the point of the heel The upper ends of this incision are joined by an elliptical incision over the front of the ankle joint (Fig 641) The incision under the foot is carried right down to the bone and the os calcis is carefully cored out of the fibro-fatty pad of the heel The foot is then strongly plantar flexed and the soft tissues in front of the ankle cut throu[gh] [an]d the foot disarticulated Soft tissues are retracted and the

l lower articular surface of the tibia sawn off transversely The
l flap is then swung up and attached to the anterior skin margin
4 *Amputations at the Hip*
(i) Disarticulation by external racquet incision (Furneaux Jordan)
(ii) Disarticulation by posterior flap (Fitzmaurice Kelly)
(iii) High femoral amputation by anterior racquet (Fig 63a)
(iv) Hindquarter (or inter innomino abdominal) amputation

All these are major procedures the hindquarter in fact being scribed as the biggest operation in the whole of surgery and details not necessary in a book of this type Certain technical points will obvious such as the necessity of preliminary ligature of major vessels d the ultimate use of a tilting table prosthesis It is perhaps rthy of note that in the last seventy three hindquarter amputations ne all over the world the immediate post-operative mortality is under per cent Naturally such a Herculean operation is only performed most serious conditions (chiefly malignant neoplasms) and so the imate mortality is considerably above this figure
5 *Amputations at the Shoulder*
(i) Disarticulation by anterior racquet incision (Spence)
(ii) Forequarter (interscapulo-thoracic) amputation by either the anterior approach of Berger (1887) or the more modern posterior approach of Littlewood

(c) **Historical Sites.**— 1 *Lisfranc s Amputation* which is really a tarso-metatarsal disarticulation
2 *Hey's Amputation* a modification of Lisfranc s the base of the second metatarsal being sawn across instead of disarticulated like the others
3 *Chopart's Amputation* a mid tarsal disarticulation.
4 *Pirogoff's Amputation* a modification of Syme s in which the posterior portion of the os calcis is left in the heel flap
5 *Watson s Amputation* a further modification of Syme s in which the whole of the os calcis (suitably shaped) is left in the heel flap
6 *Stephen-Smith s Amputation* disarticulation at the knee joint using lateral flaps
7 *Carden s Amputation*, a supracondylar amputation of the femur at the level of the adductor tubercle
8 *Stokes-Gritti Amputation* a modification of Carden s in which the femur is divided at a slightly higher level the patella being left in a long anterior flap

KINEPLASTIC STUMPS

By this term is meant an attempt to link normal tendons to mechanical appliances It was to a small extent popularised after the first Great War chiefly by Italian surgeons when some thirty cases were reported but the ultimate results have not to date justified any development of the idea It was tried chiefly in forearm amputations

A. E PORRITT

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